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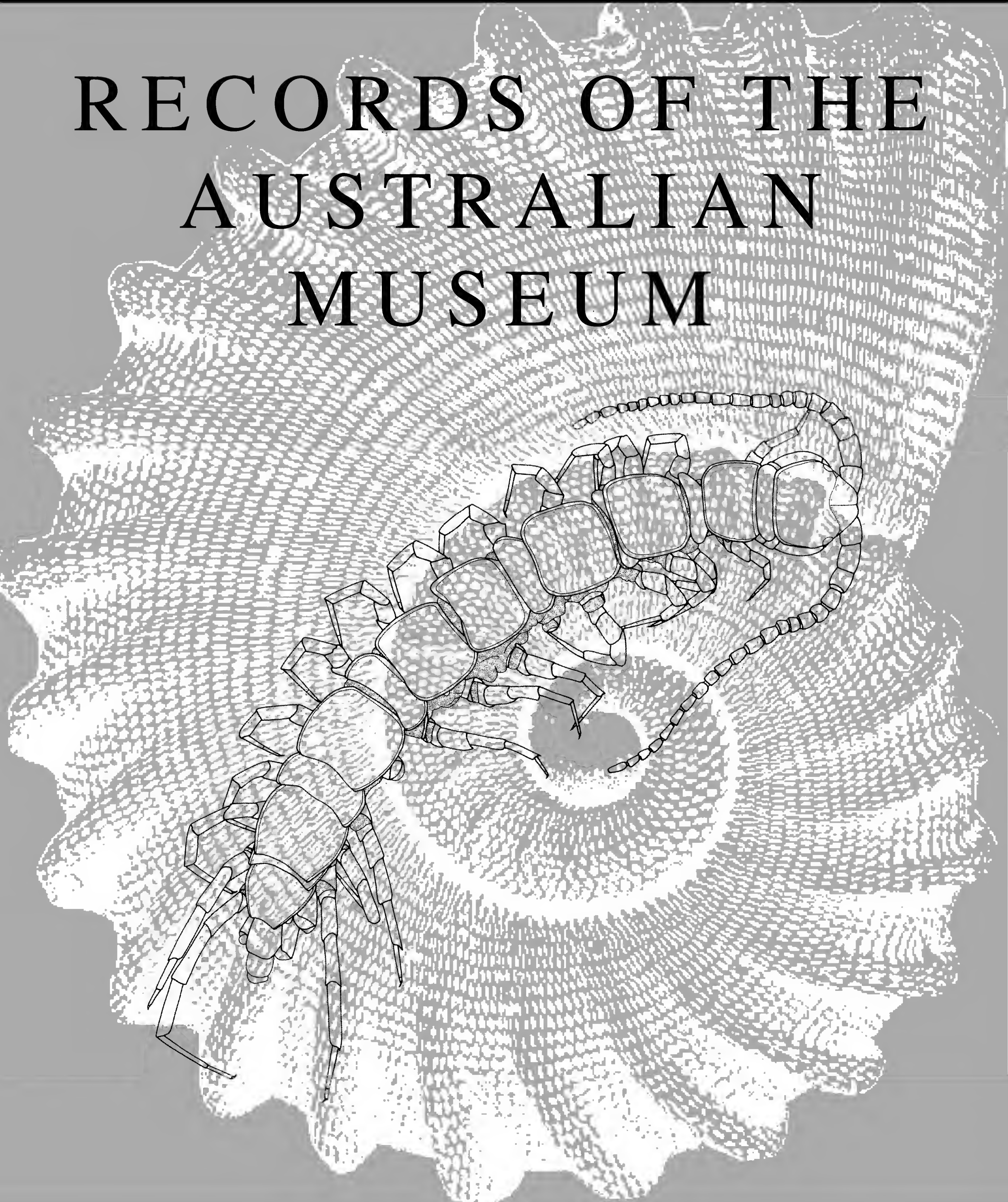

VOLUME 54 NUMBER 1 6 June 2002

RECORDS OF THE AUSTRALIAN MUSEUM

Printed 6 June 2002

Price: AU$50.00

Printed by RodenPrint Pty Ltd, Sydney

ISSN 0067-1975

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Cover illustration: *Paralamyctes hornerae* Edgecombe, 2001 (*Rec. Aust. Mus.* 53[2], p. 226)—a native Australian species of lithobiomorph centipede from the Styx River State Forest in New South Wales.
This specimen (about 16 mm) was illustrated by freelance artist Suzanne Bullock (suzanne.bullock@rbgsyd.nsw.gov.au).
The faded impression (original SEM work by Geoff Avern) of the protoconch of an obscure gastropod mollusc barely 2 mm wide, provides background.

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Records of the Australian Museum (2002) Vol. 54: 1–24. ISSN 0067-1975

A New Genus Belonging to the Family Porcellidiidae (Crustacea: Copepoda: Harpacticoida) With Three New Species from Australia

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ABSTRACT. A new genus, *Dilatatiocauda*, is defined to accommodate three new species belonging to the family Porcellidiidae. It is characterised by maxillipeds that do not meet in the mid-line or have a fimbriate process on the basis. *Porcellidium dilatatum* Hicks, 1971 possesses these features and is moved to the new genus as the type species. Three new species, *Dilatatiocauda multidenticulata*, *D. medialis* and *D. retroseta* from northern New South Wales, Australia are described and placed in the new genus. Three previously described species, *Porcellidium tristanense* Wiborg, 1964, *P. planum* Tiemann, 1977 and *P. bipartitum* Kim & Kim, 1997, although differing in some features, are considered to fall within the parameters of the new genus.

HARRIS, VERNON A., 2002. A new genus belonging to the family Porcellidiidae (Crustacea: Copepoda: Harpacticoida) with three new species from Australia. *Records of the Australian Museum* 54(1): 1–24.

The family Porcellidiidae Sars, 1904, has a rich assemblage of species in the Indo-Pacific region, Harris & Robertson (1994), Harris (1994), Harris & Iwasaki (1996a,b; 1997). A member of the Porcellidiidae with several unusual characters was described by Hicks (1971) from Wellington, Aotearoa (New Zealand) as *Porcellidium dilatatum*. This species is remarkable in having the maxillipeds widely separated (in all other members of the Porcellidiidae the coxal lobes meet in the mid-line). Three closely related species from New South Wales, Australia show the same widely spaced maxillipeds. These four species share several unique features that are not possessed by other members of the Porcellidiidae. A new genus, *Dilatatiocauda*, is proposed to accommodate them.

Porcellidium bipartitum Kim & Kim, 1997 from Korea, *P. tristanense* Wiborg, 1964 from Tristan da Cunha and *P. planum* Tiemann, 1977 from South Africa, share the same unique set of characters, although they differ in certain other respects. Their taxonomic position and possible inclusion in the new genus will be considered in the discussion.

Methods and materials

The method of study, measurement, terminology used to describe setae and selection of type population or material, follows the procedures described by Harris & Robertson (1994) and Harris & Iwasaki (1996a). Measurements were made on formalin preserved specimens. Body length was measured from anterior edge of rostrum to posterior tip of urosome. Not all features can be seen or measured on holotype or allotype specimens and so illustrations and descriptions are based on dissected paratype material. Several dissections were made for each species in order to find at least one example of each limb orientated at a

favourable angle for measurement or illustration. Numbers on illustrations refer to slides from which they were drawn. The hyaline border and antennules have been omitted from drawings of the whole animal. The delicate hyaline membrane can be seen in Plate 2B, and in details of anterior cephalosome (Figs. 7B–E; 9B,C,G,H; 11D,E).

The scanning electron micrographs were taken on an Hitachi S225 ON SEM from gold coated, formaldehyde fixed material. Geo-spatial coordinates have been extrapolated from survey maps.

Holotypes, allotypes and paratypes of the Australian species have been deposited in the Australian Museum, Sydney (AM). Paratype material has been deposited in the Natural History Museum, London (BMNH) and the National Science Museum, Tokyo (NSM Tokyo). Some material has been deposited in the National Museum of New Zealand, Wellington, and the Queensland Museum, Brisbane, other material is held by the author.

Systematics

Family Porcellidiidae Sars, 1904

Genus *Dilatatiocauda* n.gen.

Diagnosis. Anterior of female cephalosome semicircular, rostrum prominent, projects beyond cephalosome; anterior of male cephalosome truncated, male rostrum not pointed anteriorly; hyaline border on cephalosome and metasomal epimera appears granular, ducts from marginal glands open dorsal to hyaline membrane; dorsal pits present, ornamentation of net-like or honeycomb-like ridges may be present on parts of dorsal surface; labrum (hyperstome) with two grooved plates (comb plates) located near tip of mandibular incisor process; female urosome broad, division into anterior and posterior lobes indistinct, usually indicated by feint scar, anterior lobe without lateral striations, posterior lobe rounded, typically bordered with setules, caudal arch deep (≥50% of urosome length); female caudal ramus elongate, rectangular (L/W ratio ≥3), tendency to widen distally, posterior border not pointed, bevelled or deeply notched at external corner, α & β setae close or very close (L/[α–β]>5), γ seta on posterior border, terminal setae T1 to T4 present, terminal setae T2 & T3 close together; male caudal ramus short (quadrate), widens distally, setation similar to female; male antennule without anterior comb on accessory lobe, dactylus (terminal segment of antennule) lobed or expanded at its base; maxillule endopod with six setae, exopod with two setae; maxilliped medial lobes (coxae) widely separated in mid-line, basis quadrate (not elongate), no fimbriate process on basis; P1 with conspicuous area of denticulate pegs on endopod; endopod of P3 and P4 with long straight plumulose or serrulate spinous terminal seta; female P5 exopod without ventral expansion, does not extend beyond urosome; male P5 with six terminal setae.

Remarks. The genus is characterised by the unusual shape and structure of the maxillipeds which are widely separated in the mid-line and lack both the characteristic fimbriate edge and fimbriate process common to all other genera (see Fig. 1A,D,E). The presence of labial comb plates (see Fig. 1C), shape and setation of the caudal rami (Fig. 1B) as well as the unusual straight spine-like terminal seta on P3 and P4 endopod (see Fig. 8A,C) are also characteristic. The generic name *Dilatatiocauda* (gender feminine) has been compounded from Hicks' (1971) trivial name *dilatatum* which refers to the distal widening of the caudal rami, (late L. *dilatatio* = expanded, enlarged + *cauda* = tail).

Species composition. *Dilatatiocauda dilatata* (Hicks, 1971) **n.comb.**, (synonym *Porcellidium dilatatum* Hicks, 1971: 94–98, figs. 5–7), type species; *D. multidenticulata* n.sp.; *D. medialis* n.sp.; *D. retroseta* n.sp.; *Dilatatiocauda tristanensis* (Wiborg, 1964) **n.comb.**, (synonyms *Porcellidium tristanense* Wiborg, 1964: 18–19, fig. 8; *P. peniculiferum* Tiemann, 1978: 235–241, *abb.* 1–20; redescribed by Hicks, 1982: 51–59, figs. 1–17); *Dilatatiocauda plana* (Tiemann, 1977) **n.comb.**, (synonym *Porcellidium planum* Tiemann, 1977: 69–76, *abb.* 1–22); *Dilatatiocauda bipartita* (Kim & Kim, 1997) **n.comb.**, (synonym *Porcellidium bipartitum* Kim & Kim, 1997: 142–148, figs. 1–3). A key to the species of *Dilatatiocauda* is given below.

Dilatatiocauda dilatata (Hicks, 1971)

Figs. 1, 2 & 3

Porcellidium dilatatum Hicks, 1971, 94–98, figs. 5–7.

Type material. Collected from Island Bay, Wellington, Aotearoa (New Zealand), G.R.F. Hicks (see under *Distribution and abundance* below).

Diagnosis. *Adult female*: comb plates on labrum with numerous ridges (>8); sternal plate of metasomal segment 4 with ridges, not fimbriate; caudal rami rectangular (L/W ratio 3.8), α seta proximally inserted (¼ way down ramus), terminal setae T2 & T4 large, equal in size, pinnate, seta T3 plain, very thin, seta T4 set in from medial corner (⅕ width); longest geniculate seta on antenna not longer than endopod segment 2, terminal part straight, plain; large lateral area of peg-like denticles on P1 endopod (>½ width of endopod), no denticulate pegs along medial border; P4 endopod segments not fused; no chitinous striations along anterolateral edge of female P5. *Adult male*: coupling denticles of antennule small, not conspicuous; P2 with two plumose terminal setae on endopod; P5 setae unipinnate deltoid, row of ventral setules at base of each terminal seta.

Dimensions. *Female**: length 0.92 mm (rostrum to posterior tip of urosome), cephalosome width 0.58 mm, length to width ratio 1.6. Rostrum 0.18 mm wide, ratio of body width to rostrum 3.2. Urosome width to length ratio 1.2. Caudal ramus length to width ratio 3.8; dilation index 10.3 ([distal width–proximal width]/length × 100). *Male**: length 0.63 mm, width 0.46 mm, body length to width ratio 1.4. (* Measurements taken from single paratype specimens of male and female.)

Description. *Adult female*. Anterior outline of cephalosome semicircular, rostrum prominent, with hyaline border, projects about ¼ of its width. Dorsal surface ornamentation of pits indistinct except for three or four rows of pits tangential to anterior edge of cephalosome (Fig. 2A), no patches of honeycomb-like ridges on dorsal surface, hyaline border 13 µm wide, granular. Comb plates on labrum (Fig. 1C) with numerous ridges (>8). Sternal plate of metasomal segment 4 not fimbriate (i.e., without hair-like setules),

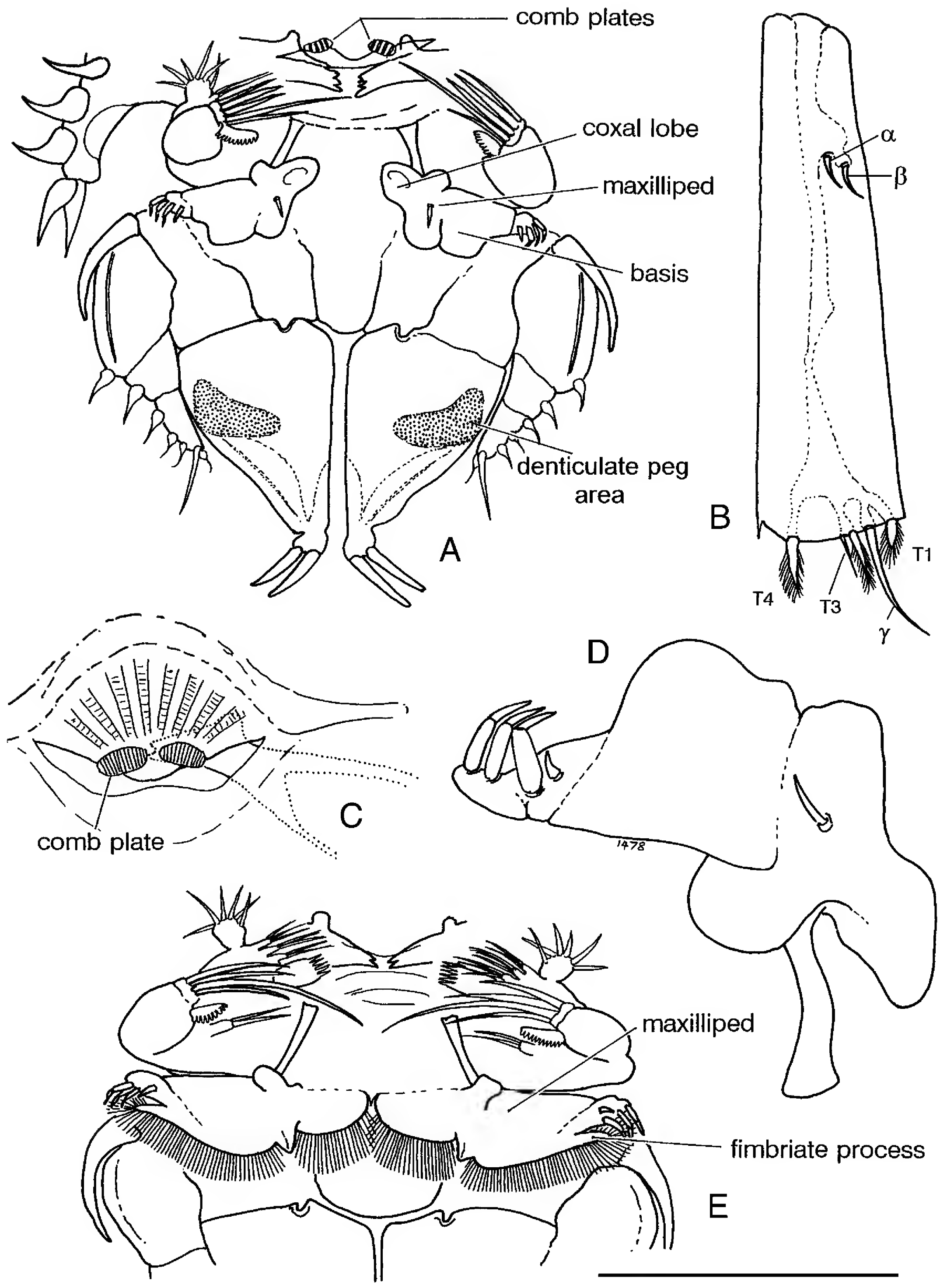

Figure 1. Characters of the genus *Dilatatiocauda* n.gen. *Dilatatiocauda multidenticulata* n.sp.: A, ventral view of mouth region and first pair of peraeopods showing combs on labrum, wide spacing of maxillipeds and denticulate areas on P1 endopod. *Dilatatiocauda dilatata* (Hicks, 1971): B, right caudal ramus showing position of α and β setae. C, combs on labrum in relation to position of mandible (dotted line). D, maxilliped showing absence of fimbriate process. *Kushia zosteraphila* Harris & Iwasaki, 1996: E, showing close juxtaposition of maxillipeds and presence of fimbriate process. Scale bar: A,E = 0.15 mm; B = 0.1 mm; C = 0.133 mm; D = 0.06 mm.

ornamented with numerous ridges running parallel to body axis (Fig. 2F). Urosome broad (Fig. 2E), very small notch and indistinct scar mark boundary between anterior and posterior lobes, anterior lobe without marginal setules, posterior lobe with strong, lanceolate marginal setules, one sensory seta on posterior border. Caudal arch deep (58% of urosome length). Caudal rami (Fig. 1B) elongate, rectangular, expanding distally, terminal border straight except for slight bevel at medial corner. Alpha seta proximal (situated about ¼ way down ramus). Hicks' index (distance

Key to the species of *Dilatatiocauda*

1	Denticulate area on P1 endopod small (less than ½ width of endopod)	2
——	Denticulate area on P1 endopod large (equal or greater than ½ width of endopod)	3
2	P4 endopod 2-segmented, α and β setae on female caudal ramus not very close (α ⅓, β ½ way down ramus)	*bipartita*
——	P4 endopod 3-segmented, α and β setae on female caudal ramus very close, α and β ⅓ way down ramus, sides of caudal ramus almost parallel, dorsal surface smooth (no reticulate ridges), no notch at posterior apex of female P5	*plana*
——	P4 endopod 3-segmented, α and β setae on female caudal ramus very close, α and β ½ way down ramus, caudal ramus widens distally, dorsal surface with strong reticulate ridges, female P5 with notch at posterior apex	*medialis*
3	Geniculate setae on antenna J-shaped, much longer than segment 2 of endopod, P1 endopod with medial denticulate area	4
——	Geniculate setae on antenna L-shaped, equal or shorter than segment 2 of endopod, no medial denticulate area on P1 endopod	5
4	Female caudal ramus widens posteriorly, terminal seta T2 very small	*tristanensis*
——	Female caudal ramus sides almost parallel, terminal seta T2 pinnate, same size as T4	*retroseta*
5	Female caudal ramus setae T2 & T3 pinnate, equal in size, male antennule with conspicuous coupling denticles, comb plates on labrum with only 4 or 5 ridges, sternum of metasome segment 4 fimbriate	*multidenticulata*
——	Female caudal ramus seta T3 very thin, plain, male antennule coupling denticles not conspicuous, comb plates on labrum with about 10 ridges, sternum of metasome segment 4 ridged	*dilatata*

of α from distal border/L × 100) = 73%. Alpha and beta setae very close (L/[α–β] = 44), terminal seta T1 short, pinnate, setae T2 and T4 large, pinnate, equal in size, seta T3 plain, thin (difficult to see on some specimens), T2 and T3 very close, seta T4 set in from medial corner (16% of width), terminal fringe of fine setules present between seta T2 and medial corner (Fig. 2I). Limbs: Antenna exopod with five plumulose setae plus one spinose seta. Segment 1 of endopod with diagonal row of triangular setules, marginal seta absent, segment 2 with two lateral setae plus six terminal setae, longest geniculate seta equal to length of segment 2, terminal part straight, plain, claw (terminal seta) comb-like. Medial lobe of maxilliped coxa reduced, widely separated from its partner (compare Fig. 1A), not fimbriate, basis quadrate without fimbriate border, fimbriate process absent (Fig. 1D). First segment of P1 exopod with conspicuous ridge of closely packed denticles parallel to edge (Fig. 3B), lateral denticulate peg area on P1 endopod large (>½ width of endopod), medial denticulate pegs absent, striated band parallel to fimbriate crescent V-shaped. Spinous seta on P3 endopod segment 2 serrulate, short (seta:endopod = 0.7:1), sickle-shaped spinous seta on segment 3 serrate, much longer than endopod (1.5:1), long straight spine-like terminal seta finely serrulate (Fig. 2D). Segments 2 and 3 of P4 endopod not fused. Coxa-basis of P5 with row of marginal setules, exopod lanceolate with falciform ridge, three dorsal setae close to apex plus one apical seta. Females with 14–16 eggs in their ovisac.

Adult male. Shoulders angular with small "epaulet", lateral angle of antennule socket not visible from above, three tangential rows of pits on anterior part of cephalosome (Fig. 2B). Rostrum does not project beyond cephalosome, rostrum width 0.07 mm, cephalosome width to rostrum ratio 6:1. Caudal ramus (Fig. 2C) short (L/W = 1.2), setation as for female, T3 same size as T2. Antennule coupling denticles not conspicuous, not obviously denticulate, accompanied by short plumose seta, anterior lobe lies almost parallel to anterior edge of antennule, ventral process (blade) present, aesthetasc not bulbous at base, dactylus (terminal segments of antennule) with expanded lobe (Fig. 2G). P2 endopod with two terminal plumose setae. P4 endopod segments 2 and 3 not fused. P5 with six unipinnate deltoid terminal setae, each seta with a row of ventral setules at its base (Fig. 2H).

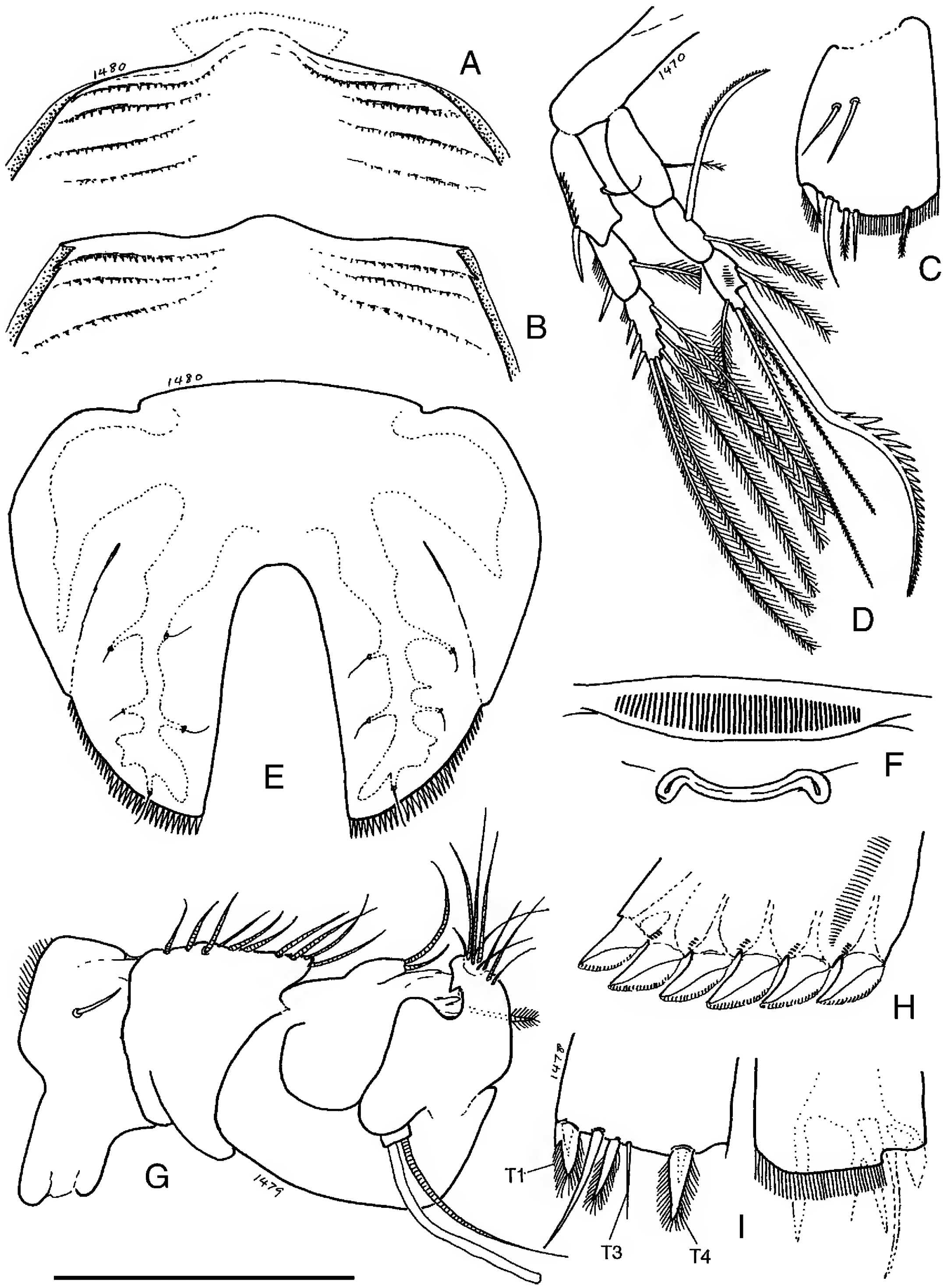

Figure 2. *Dilatatiocauda dilatata* (Hicks, 1971): A, anterior of female cephalosome, dorsal view. B, anterior of male cephalosome, dorsal view. C, left male caudal ramus. D, P3. E, female urosome, dorsal view. F, ventral view of metasome segment 4 sternal plate showing ridges. G, left male antennule, ventral view (π setae not shown). H, setae and ventral setules of male P5. I, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,B, 0.3 mm; C,G,H = 0.1 mm; D = 0.17 mm; E = 0.225 mm; I = 0.08 mm; F, not to scale.

Remarks. The above description is based on Hicks' original description and paratype material kindly supplied by Dr Hicks. Careful examination of his material reveals that the female caudal ramus has four terminal setae as well as the γ seta. However, T3 is very thin and not easily seen on female animals. On male animals T3 is the same size as T2. The terminal segment of P1 exopod has 4 pilose bulbous marginal setae, one straight seta and a plumose internal seta. The rows of setules (spinules) between terminal setae on the male P5 are located on the ventral surface of this appendage. The male antennule has an expanded lobe to the dactylus.

The ridged ventral (sternal) surface of the female's fourth metasomal segment is an easily visible diagnostic feature of this species. *Dilatatiocauda dilatata* is the type species of the genus.

Distribution and abundance. The following information is given by Hicks (1971) about type material: Holotype: holotype female is deposited in the New Zealand Oceanographic Institute (NZOI) collection, Wellington (Reg. No. 71). Paratypes: one male deposited in NZOI collection (Reg. No. P129). Pairs (1 ♂ and 1 ♀) in: Dominion Museum, Wellington (Z.Cr.1863); British Museum (Natural History) (BMNH 1969.12.1.1); U.S. National Museum (USNM 128136); NZOI collection (Reg. No. P130).

The type material was taken in a net from amongst various sub-littoral seaweeds at Island Bay, Wellington, in January 1970 (NZOI Sta. Z 2320).

Dilatatiocauda multidenticulata n.sp.

Figs. 1, 3–6

Type material. HOLOTYPE adult female with egg mass removed, length 0.85 mm, AM P58798. ALLOTYPE adult male, length 0.61 mm, AM P58799. Type population collected from *Dictyopteris* sp., infralittoral fringe, Nambucca Heads reef, New South Wales (30°37'S 152°58'E), Australia, 5.11.82, V.A. Harris. PARATYPE material: NSM Tokyo Cr13415, 30 ♀♀ & ♂♂ + juveniles. Designated paratype material from *Zonaria* sp., Ballina, N.S.W. (28°52'S 153°36'E), 2.11.82, AM P58801, 30♀♀, 11♂♂ + 7 coupled ♂♂. Designated paratype material from *Dictyopteris* sp., Ballina, N.S.W., 2.11.82, BMNH 2000.1190–1250, 40♀♀, 21♂♂.

Material collected from Sydney and the northern coast of New South Wales by V.A. Harris: BALLINA, Pontoon rocks, (28°52'S 153°36'E), 1.11.82, washed from *Pterocladia* sp.,1 ♀; *Sargassum* sp., 384♀♀, 48♂♂ + 113 coupled ♂♂; unidentified red seaweed 42♀♀, 6♂♂ + 9 coupled ♂♂; *Ecklonia radiata* 10♀♀, 2♂♂ + 2 coupled ♂♂; *Ecklonia radiata* holdfast 14♀♀, 10♂♂ + 7 coupled ♂♂; Zonaria sp., 21♀♀, 12♂♂ + 9 coupled ♂♂, 2.11.82, washed from *Zonaria* sp., 124♀♀, 45♂♂ + 17 coupled ♂♂ [designated paratype material]; *Dictyopteris* sp., 83♀♀, 49♂♂ + 8 coupled ♂ [designated paratype material]; *Sargassum* sp., 12♀♀, 2♂♂; *Rhodymenia australis* 1♀, 1♂ + 2 coupled ♂♂; washed from rocks encrusted with pink coralline weed 3♀, 1♂. ARRAWARRA HEADLAND, (30°03'S 153°02'E), 3.11.82, washed from *Caulerpa* sp., 2♀♀, 1♂ + 3 coupled ♂♂; *Sargassum* sp., 2♀♀, 2♂♂ + 2 coupled ♂♂; rocks encrusted with pink coralline weed 1♀, 4.11.1982, *Dictyopteris* sp., 45♀♀, 42♂♂ + 23 coupled ♂♂; *Dictyopteris* sp., + *Lobophora* sp., 39♀♀, 13♂♂ + 5 coupled ♂♂; *Caulerpa* sp., 18♀♀, 6♂♂ + 7 coupled ♂♂; mixed weed from coral pool, 26♀♀, 7♂♂ + 4 coupled ♂♂. NAMBUCCA, (30°39'S 153°01'E), 5.11.82, washed from *Sargassum* sp., 13♀♀, 6♂♂ + 5 coupled ♂♂; *Dictyopteris* sp., 169♀♀, 84♂♂ + 53 coupled ♂♂ [type population]; *Gelidium* sp., 3♀♀; mixed weed (*Hormosira, Sargassum, Caulerpa* sp.), 9♀♀, 2♂♂ + 8 coupled ♂♂; *Halimeda* sp., 1♀, 1 coupled ♂; *Sargassum* sp. and *Halimeda* sp. growing under overhanging rocks, 141♀♀, 97♂♂ + 63 coupled ♀♀; *Ecklonia radiata* 4♀♀, 1♂ + 1 coupled ♂; *Padina* sp., 33♀♀, 10♂♂ + 6 coupled ♂♂. CRONULLA, Shelly Beach rocks, Sydney, (34°03'S 151°11'E), 7.2.74, washed from *Dilophus marginatus* 3♀♀, 1♂; *Sargassum* sp., 4♀♀, 2♂♂, 21.8.75, *Dictyopteris* sp., 104♀♀, 34♂♂ + 39 coupled ♂♂, 17.2.77, *Sargassum* sp., 81♀♀, 15♂♂ + 32 coupled ♂♂; *Pterocladia* sp., 109♀♀, 30♂♂ + 4 coupled ♂♂; *Dictyopteris* sp., 270♀♀, 158♂♂ + 30 coupled ♂♂; coralline weed 14♀♀, 8♂♂; *Dictyopteris* sp., 390 animals (not sorted); *Cystophora* sp., 20 animals (not sorted); *Ecklonia radiata* 25 animals (not sorted); rocks 17 animals (not sorted); 18.2.77, *Sargassum* sp. and other seaweeds 146 animals (not sorted); *Lobophora* sp. and *Padina* sp., 20 animals (not sorted).

Diagnosis. *Adult female*: dorsal pits small, not conspicuous; comb plates on labrum with 4 or 5 ridges; sternal plate of metasomal segment 4 without ridges, posterior edge fimbriate; caudal rami elongate, rectangular (L/W = 4.0), α seta proximal (inserted ⅕ down ramus); terminal seta T1 short, thick, pinnate, T2, T3, and T4 pinnate, equal in size, seta T4 set in from medial corner (¼ width of ramus); longest geniculate seta on antenna not longer than endopod segment 2; lateral denticulate peg area on P1 endopod large (= ½ width of endopod), no denticulate pegs along medial edge; segments 2 and 3 of P4 endopod not fused; no chitinous striations along anterolateral edge of female P5. *Adult male*: antennule coupling apparatus with 3 conspicuous denticulate pads, dactylus with expanded lobe; P2 endopod with 2 terminal setae; rows of ventral setules absent at base of terminal setae on P5.

Dimensions. *Females*: mean length 0.84 mm (SD = 0.023, N = 30), cephalosome width 0.53 mm (SD = 0.013, N = 30), body length to width ratio 1.6. Rostrum width 0.15 mm, ratio of body width to rostrum 3.5. Urosome width to length ratio 1.37. Caudal ramus length to width ratio 4.0; dilation index 5.3. *Males*: mean length 0.58 mm (SD = 0.009, N = 21), width 0.43 mm (SD = 0.007, N = 21), ratio of body length to width 1.35.

Description. *Adult female* (Fig. 4A). Pale amber yellow or colourless with red eye spot. Anterior of cephalosome semicircular. Rostrum prominent with hyaline border, projects ⅖ of width (Fig. 5A). Dorsal pits small (about 1–2 µm in diameter). Scanning electron micrographs show a fine network of ridges surrounding pits and many sensory setae with basal collar (Plate 1A). Hyaline border of cephalosome 13 µm wide, granular. Comb plates on labrum short each with 4 or 5 ridges (Fig. 4G). Sternal plate of metasomal segment 4 with hair-like setules along posterior edge (fimbriate), ridges absent (Fig. 4C). Urosome broad (Fig. 4B), division between anterior and posterior lobes marked by scar and very slight notch, no cleft, anterior lobe without marginal setules, posterior lobe with strong lanceolate marginal setules, one sensory seta on posterior border, medial corner square. Caudal arch very deep (57% of urosome length). Caudal ramus (Fig. 6A) elongate, rectangular, dilation very small, sides almost parallel. Alpha seta proximally inserted (Hicks' index = 80%). Alpha and beta setae very close ($L/[\alpha - \beta] = 48$). Terminal seta T1 short, thick, pinnate, setae T2, T3 & T4 pinnate, equal in size, setae T2 and T3 close together, seta T4 set in from medial corner of ramus (¼ of width), terminal fringe of fine setules present (Fig. 4H).

Limbs typical of family. Antenna exopod with five plumulose setae plus spinous seta (Fig. 4F). Segment 1 of endopod without seta or diagonal row of triangular setules, segment 2 with three lateral setae and six terminal setae, longest geniculate seta as long as segment 2, terminal portion straight, finely serrulate, fine comb on claw (Fig. 4F shows the small terminal aesthetasc (*) which is present on all species, but usually obscured by the geniculate setae).

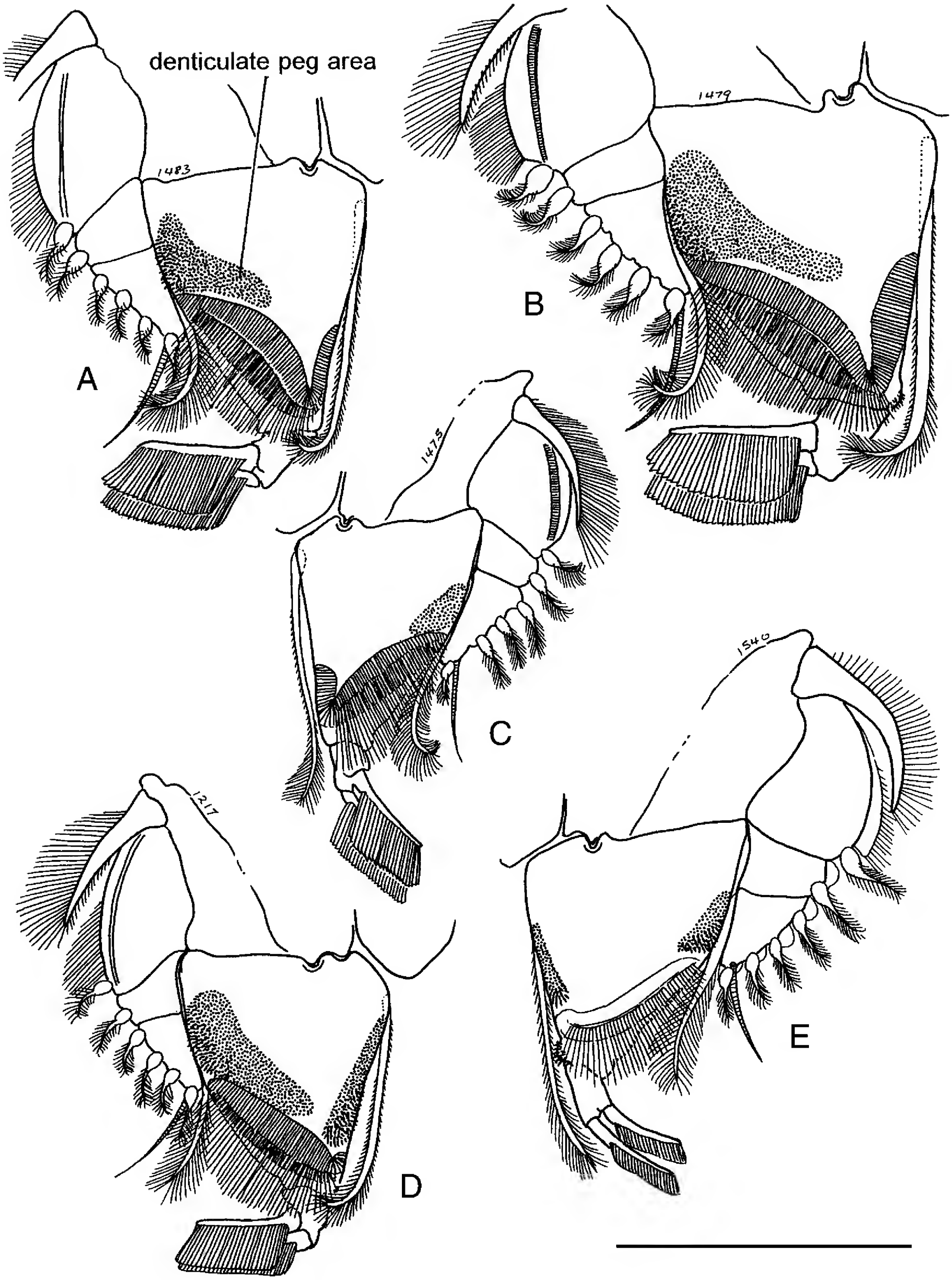

Figure 3. Comparison of first peraeopods (ventral view, denticulate area stippled). A, *Dilatatiocauda multidenticulata* n.sp., P1 right limb. B, *D. dilatata* (Hicks, 1971), P1 right limb. C, *D. medialis* n.sp., P1 left limb. D, *D. retroseta* n.sp., P1 right limb. E, *D. bipartita* (Kim & Kim, 1997), P1 left limb. Scale bar: A = 0.1 mm; B = 0.08 mm; C,D, 0.133 mm; E = 0.17 mm.

Maxilliped (Fig. 5E), coxal plates reduced, widely separated in mid-line, not fimbriate, basis broad, not fimbriate, fimbriate process absent. P1 (Fig. 3A), first segment of exopod with plain ridge parallel to edge, endopod with large triangular denticulate peg area (= ½ width of endopod), no medial peg area, striated band parallel to fimbriate crescent V-shaped. P3 (Fig. 5D), spinose seta on endopod segment 2 serrate, almost as long as endopod (0.9:1), J-shaped spinous seta on segment 3 serrate, longer than endopod (1.4:1), long straight spine-like terminal seta finely serrulate. P4 endopod segments 2 and 3 not fused (Fig. 5C). P5 exopod lanceolate, three dorsal setae near posterior end (first very

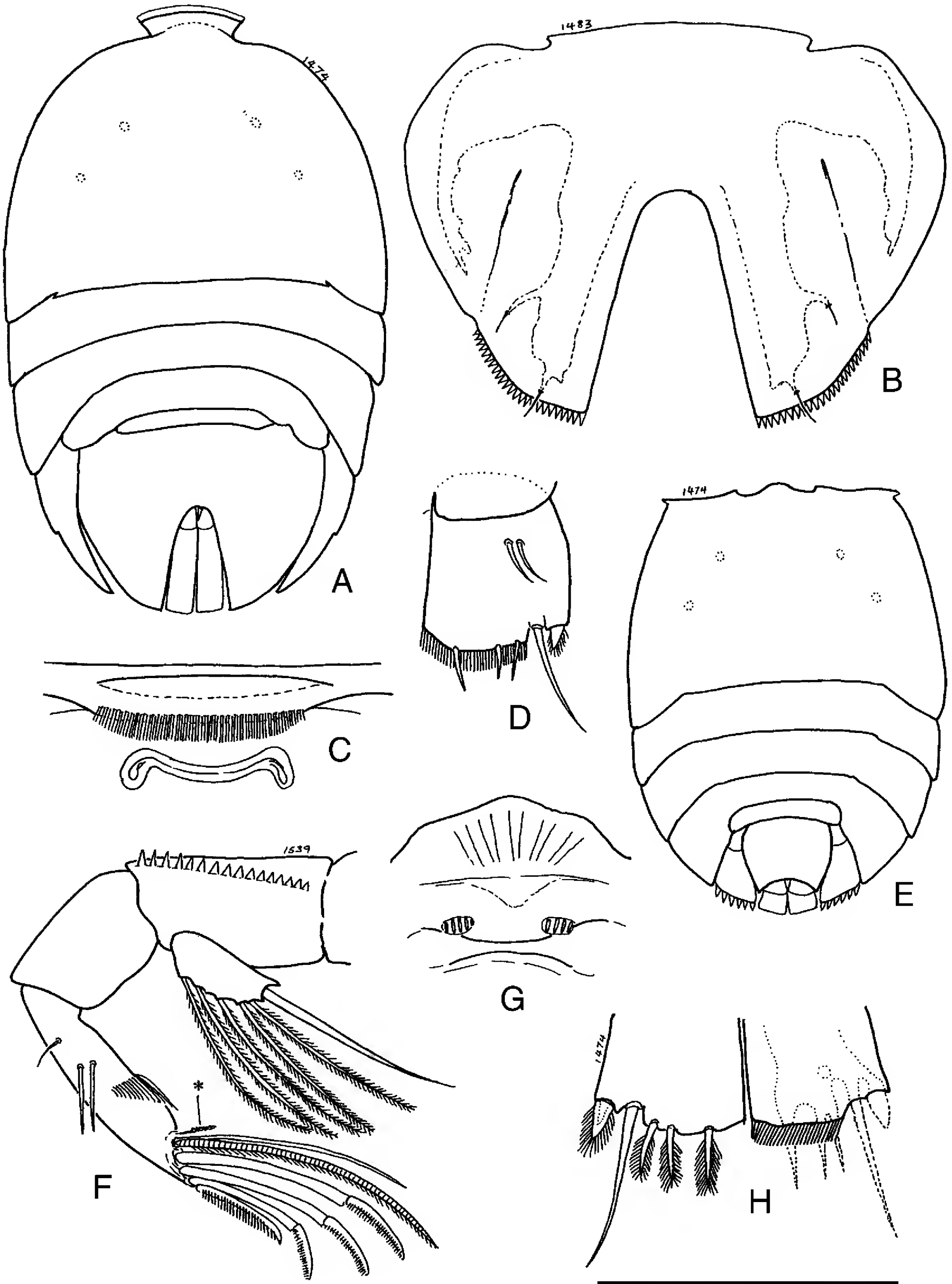

Figure 4. *Dilatatiocauda multidenticulata* n.sp.: A, female. B, female urosome, dorsal view. C, fimbriate border to metasome segment 4 sternal plate. D, male right caudal ramus. E, male. F, antenna, showing small aesthatasc (*) on endopod segment 2 just above terminal setae. G, comb plates on labrum. H, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,E = 0.45 mm; B = 0.225 mm; C = 0.133 mm; D,F,H = 0.08 mm; G = 0.125 mm.

small) plus small apical seta (Fig. 5I). Females with 10–14 eggs in ovisac (mode 12, $N = 35$).

Adult male (Fig. 4E). Yellow or colourless. Truncated anterior of cephalosome straight, shoulders angular with epaulet (Fig. 5B), lateral angle of antennule socket not seen from dorsal view. Rostrum very narrow (0.03 mm wide), cephalosome width to rostrum ratio 14:1. Caudal ramus short, almost quadrate (L/W = 1.12), setation similar to female (Fig. 4D). Anterior process and δ seta on compound segment project anteriorly (Fig. 5F,G), ventral sensory lobe with short aesthetasc and σ seta (= length of compound

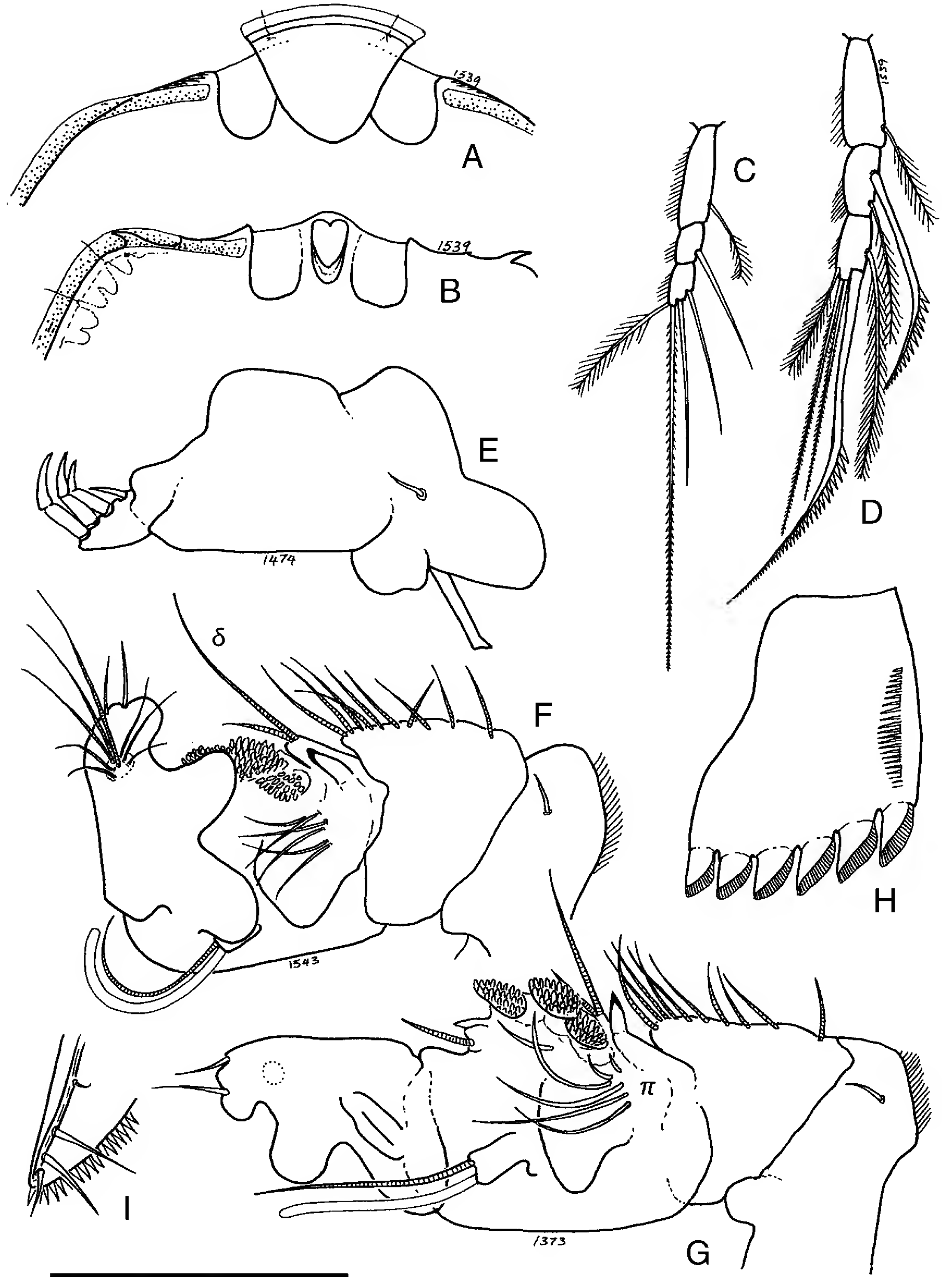

Figure 5. *Dilatatiocauda multidenticulata* n.sp.: A, anterior of female cephalosome, ventral view (hyaline border stippled). B, anterior of male cephalosome, ventral view. C, P4 endopod. D, P3 endopod. E, maxilliped. F, right male antennule, ventral view with dactylus adducted. G, same with dactylus abducted (extended) to show coupling denticles and π series setae. H, male left P5, ventral view. I, apex of female P5 showing dorsal setae. Scale bar: A,B = 0.225 mm; C,D = 0.15 mm; E = 0.06 mm; F,G,H = 0.08 mm.

segment), aesthetasc not bulbous at base, ventral process or blade present, coupling apparatus with three large, conspicuous, denticulate pads, dactylus with expanded lobe (Fig. 5G). Endopod of P2 terminates in two plumose setae. First terminal seta of P5 with row of about 20 ventral setules, no setule rows at base of other setae (Fig. 5H).

Remarks. *Dilatatiocauda multidenticulata* is easily distinguished from other members of the genus by three large, clearly visible, multi-denticulate coupling denticles on the male's antennule. The specific name refers to this feature. Scanning electron micrographs reveal a fine surface network of ridges that surround the small, indistinct dorsal

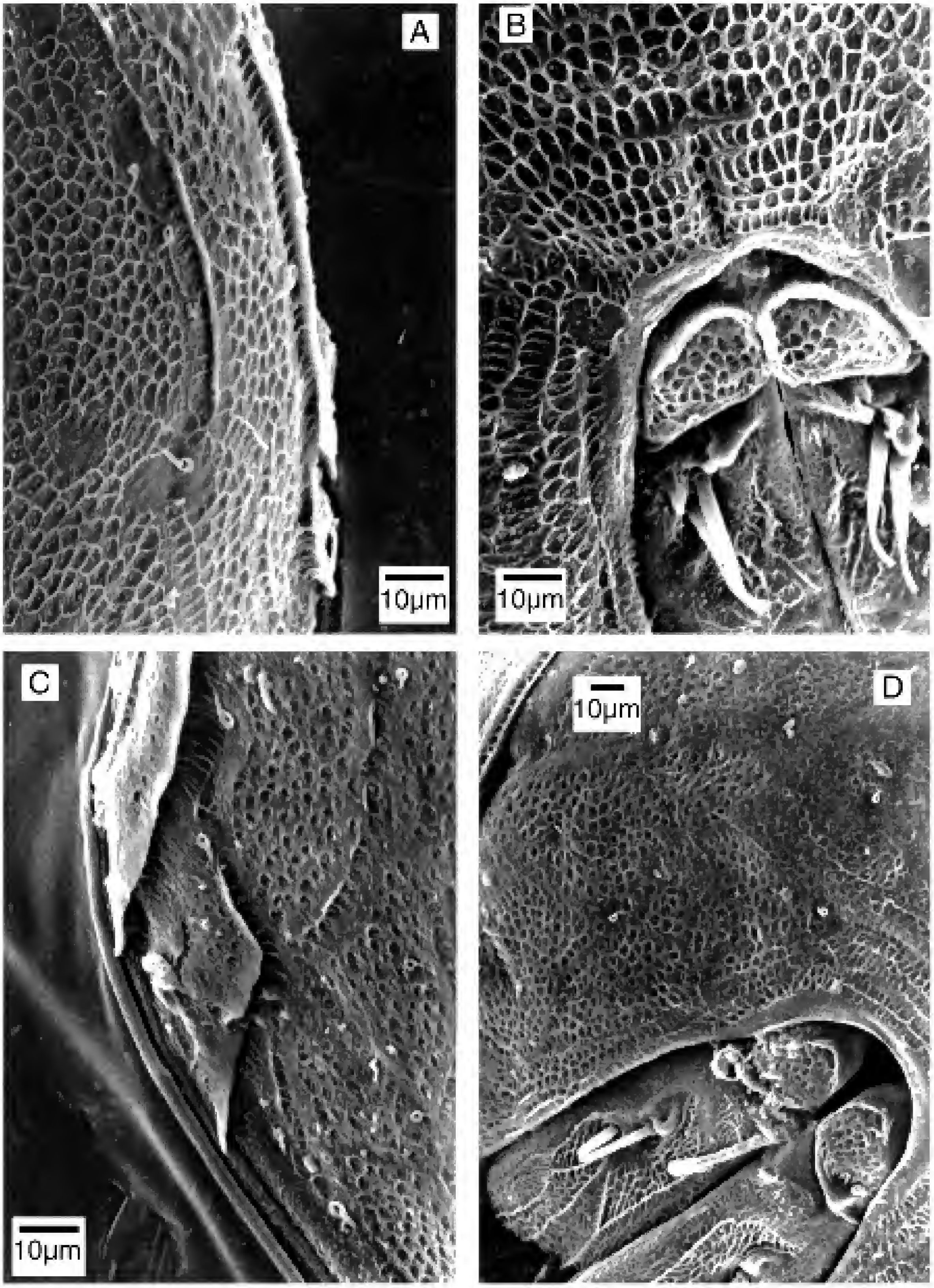

Plate 1. *Dilatatiocauda multidenticulata* n.sp. A, dorsal surface of cephalosome (right side) showing dorsal pits (c. 1–2 µm) and network of ridges surrounding pits. Several collared sensillae are visible. B, part of urosome and caudal rami showing network of strong ridges and close proximity of α & β setae. *Dilatatiocauda medialis* n.sp. C, left "shoulder" of cephalosome showing pits, collared sensillae and dorsal folds. D, part of urosome and caudal rami showing pattern of strong ridges on caudal rami.

pits (Plate 1A,B), but the dorsal surface of the cephalosome lacks honeycomb-like structures.

Distribution and abundance. This species is widely distributed along the northern coast of New South Wales. It has been recorded as abundant from Ballina on the north coast down to Sydney, but it is not known from the southern coast of New South Wales. It has not been found in the Hervey Bay–Fraser Island region of Queensland (latitude 25°S). Large populations (100+)* have been found on many species of seaweed (*Cystophora* sp., *Dictyopteris* sp., *Dilophus* sp., *Pterocladia* sp., *Sargassum* sp., *Zonaria* sp., and stones encrusted with pink coralline algae). Less frequently, it has been found on *Ecklonia radiata*, *Caulerpa* sp., and *Lobophora variegata*. (* Sample size about 0.5 kg wet seaweed.)

Dilatatiocauda medialis n.sp.

Figs. 3, 6–8

Type material. HOLOTYPE adult female without egg mass, length 0.88 mm, AM P58794. ALLOTYPE adult male, length 0.65 mm, AM P58795. PARATYPES, BMNH 2000.1251–1252, 1♀, 1♂. Type material pooled from *Sargassum* sp., (7) and *Dictyopteris* sp., (9), infralittoral fringe, rock headland Cronulla, Sydney (34°03'S 151°11'E), Australia, 17.2.77, V.A. Harris.

Material collected from Shelly Beach rocks, Cronulla, Sydney, New South Wales by V.A. Harris, 7.2.74; *Dilophus marginatus* 1♂; *Sargassum* sp., 1♀, 1♂, 21.8.75; *Dictyopteris* sp., 1♀, 17.2.77; *Dictyopteris* sp., 2♀♀; stones with coralline incrustation 1♀; *Ecklonia radiata* 2♀♀; *Dictyopteris* sp., 4♀♀, 1♂; coralline weed 1♀, 1♂; *Sargassum* sp. with other weeds 4♀♀, 1♂, 18.2.77.

Diagnosis. *Adult female*: conspicuous dorsal fold parallel to anterior edge of cephalosome; comb plates on labrum with numerous ridges (>8); sternal plate of metasome segment 4 fimbriate, not ridged; caudal rami elongate, rectangular (L/W = 3), widen posteriorly, dorsal surface with network of ridges, α seta inserted ½ way down ramus; terminal seta T3 slender, plain, seta T4 set in from medial corner; longest geniculate seta of antenna not longer than length of endopod segment 2; area of denticulate pegs on P1 endopod small (<½ endopod width), no medial peg area; segments 2 & 3 of P4 endopod not fused; no chitinous striations along anterolateral border of P5, posterior extremity of P5 notched. *Adult male*: antennule coupling denticles not conspicuous or denticulate; P2 endopod with two plumose terminal setae; P5 with ventral setule row to first seta, no setule rows at base of other terminal setae.

Dimensions. *Females*: mean length 0.92 mm ($N = 6$) range 0.88–0.93 mm, cephalosome width 0.64 mm, body length to width ratio 1.4. Rostrum 0.18 mm, body width to rostrum ratio 3.55. Urosome width to length ratio 1.25. Caudal ramus length to width ratio 3.0; dilation index 15. *Males*: mean length 0.7 mm ($N = 5$) range 0.67–0.72 mm, cephalosome width 0.58 mm, body length to width ratio 1.2.

Description. *Adult female* (Fig. 7A) pale yellow or colourless. Anterior outline of cephalosome rounded, slightly truncated, body outline ellipsoidal. Rostrum broad, prominent with hyaline edge, projects ⅓ of its width. Dorsal surface of body ornamented with pits (c. 3 µm), conspicuous dorsal fold parallel to anterior edge of cephalosome (Fig. 7B,C and Plate 1C), conspicuous reticulate ridges on dorsal surface of caudal rami (Fig. 6B and Plate 1D). Hyaline border 13 µm wide, granular in appearance. Comb plates on labrum (Fig. 8F) with numerous ridges (>8). Sternal plate of metasomal segment 4 not ridged, posterior border with fine hair-like setules. Urosome broad (Fig. 7I), no cleft, small notch and scar mark boundary between anterior and posterior lobe. Anterior lobe without marginal setules, posterior lobe with strong marginal setules, two sensory setae on posterior border, medial corner square. Caudal arch very deep (66% of urosome length). Caudal rami elongate, lateral edge slightly convex, widen posteriorly (Fig. 6B). Alpha seta near middle of ramus (Hicks' index 55%). Alpha and beta setae close ($L/[\alpha-\beta] = 18$). Terminal seta T1 short, thick, pinnate (Fig. 7J), setae T2 and T4 longer, pinnate, seta T3 plain, slender, very close to T2, T4 set in from medial corner (¼ ramus width), terminal fringe of fine setules present between T2 and medial corner.

Limbs typical of family. Exopod of antenna with five plumulose setae and one spinous seta. Segment 1 of endopod without seta or marginal setules, longest geniculate seta not longer than segment 2, terminal part straight finely serrulate, claw long with fine comb-like edge (Fig. 7F). Coxal lobe of maxillipeds reduced, widely separated from opposite side, not fimbriate; basis quadrate, not fimbriate, fimbriate process absent (Fig. 7G). First segment of P1 exopod with denticulate ridge parallel to edge (Fig. 3C), lateral denticulate peg area on endopod of P1 small (<½ width of endopod), no denticulate pegs along medial edge, striated band parallel to fimbriate crescent V-shaped. Spinous seta on P3 endopod segment 2 slender, serrulate, almost as long as endopod (0.9:1), sickle shaped serrate spinous seta on segment 3 longer than endopod (1.5:1), long straight spinous terminal seta on segment 3 serrulate (Fig. 8C). External spinous seta on segment 1 of P3 and P4 exopod very long (= segment 1), segments 2 and 3 of P4 endopod not fused (Fig. 8A). P5 exopod ovo-lanceolate, expanded dorsal part does not reach back as far as posterior apex and leaves a conspicuous notch close to the four terminal dorsal setae near apex (Fig. 8B), marginal setules strong, anterolateral chitinous striations absent.

Adult male (Fig. 7H). Pale yellow or colourless. Shoulder rounded with two dorsal folds parallel to anterior edge of cephalosome and ending in a small epaulet laterally (Fig. 7D,E), hyaline border passes round shoulder, lateral angle of antennule socket not prominent. Rostrum broad (0.07 mm), cephalosome width to rostrum ratio 8. Caudal rami quadrate (L/W = 1), dorsal surface with reticulate ridges, setation similar to female (Fig. 8D). Coupling denticles on antennule elongate, tooth-like, not denticulate, associated seta plumose (Figs. 8G,I), δ seta projects anteriorly, ventral process (blade) with finely ridged surface (Fig. 8H), aesthetasc without bulbous base, dactylus with large basal expansion. P2 endopod terminates in two plumose setae. First terminal seta of P5 with long row of ventral setules, remaining setae without row of setules at their base (Fig. 8E).

Remarks. *Dilatatiocauda medialis* is characterised by the position of the α seta which is inserted about the middle of the caudal ramus. The specific name refers to this feature

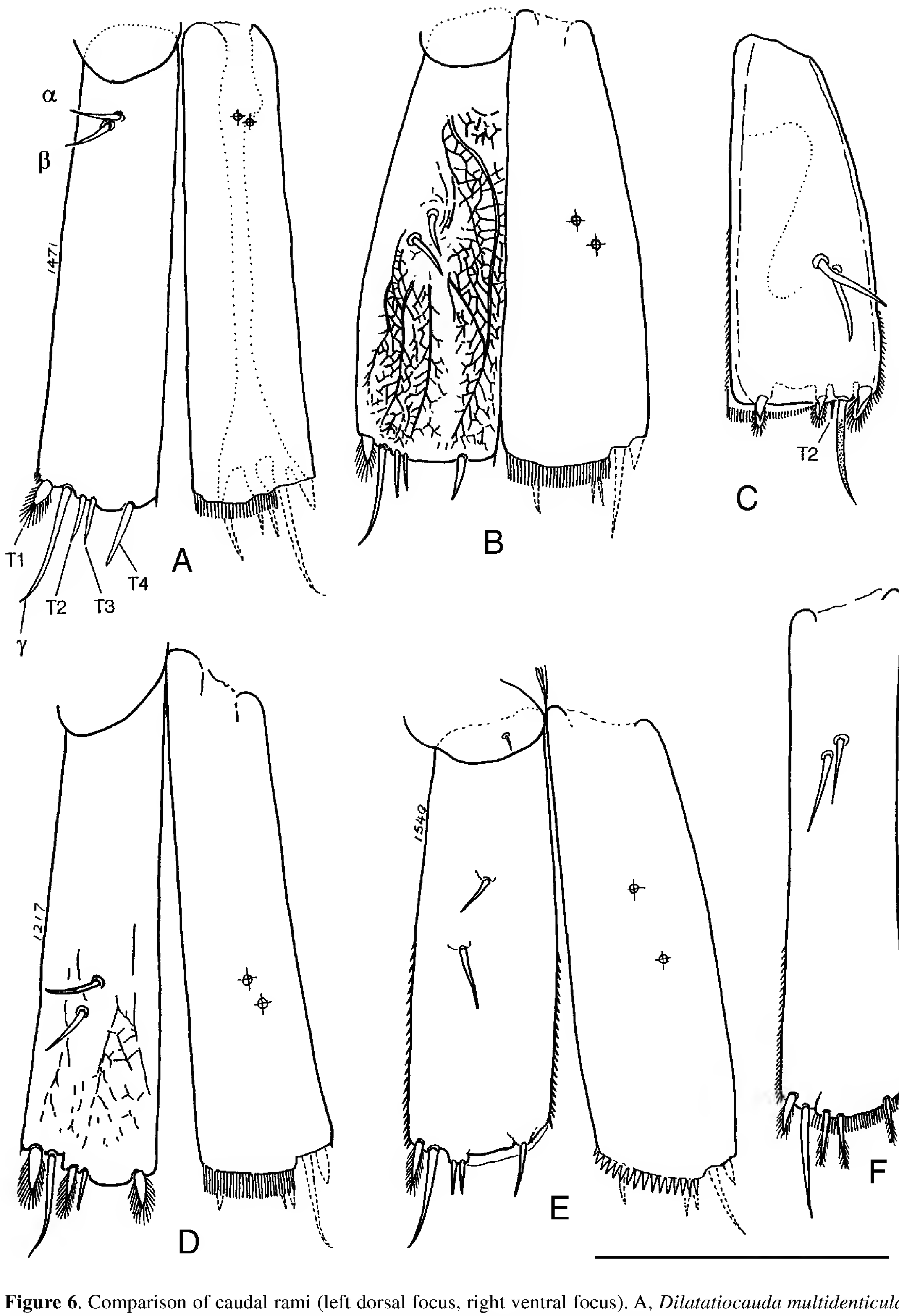

Figure 6. Comparison of caudal rami (left dorsal focus, right ventral focus). A, *Dilatatiocauda multidenticulata* n.sp. B, *D. medialis* n.sp., showing dorsal reticulate pattern. C, *D. tristanensis* (Wiborg, 1964), right caudal ramus, after Hicks (1982). D, *D. retroseta* n.sp. E, *D. bipartita* (Kim & Kim, 1997), (left ramus slightly foreshortened). F, *D. plana* (Tiemann, 1977), left caudal ramus, after Tiemann (1977). Scale bar: A,B,D,F = 0.1 mm; C,E. = 0.133 mm.

(L. *medius* = middle). Other distinctive features are the broad oval body (L/W = 1.4) and the conspicuous reticulate ridges on the caudal rami.

Distribution and abundance. No large population of this species has been found. The pooled type material has been separated from populations of the more abundant *D. multidenticulata* with which it is associated. Animals in small numbers have been found on *Sargassum* sp., and *Dictyopteris* sp., at Cronulla, Sydney, New South Wales.

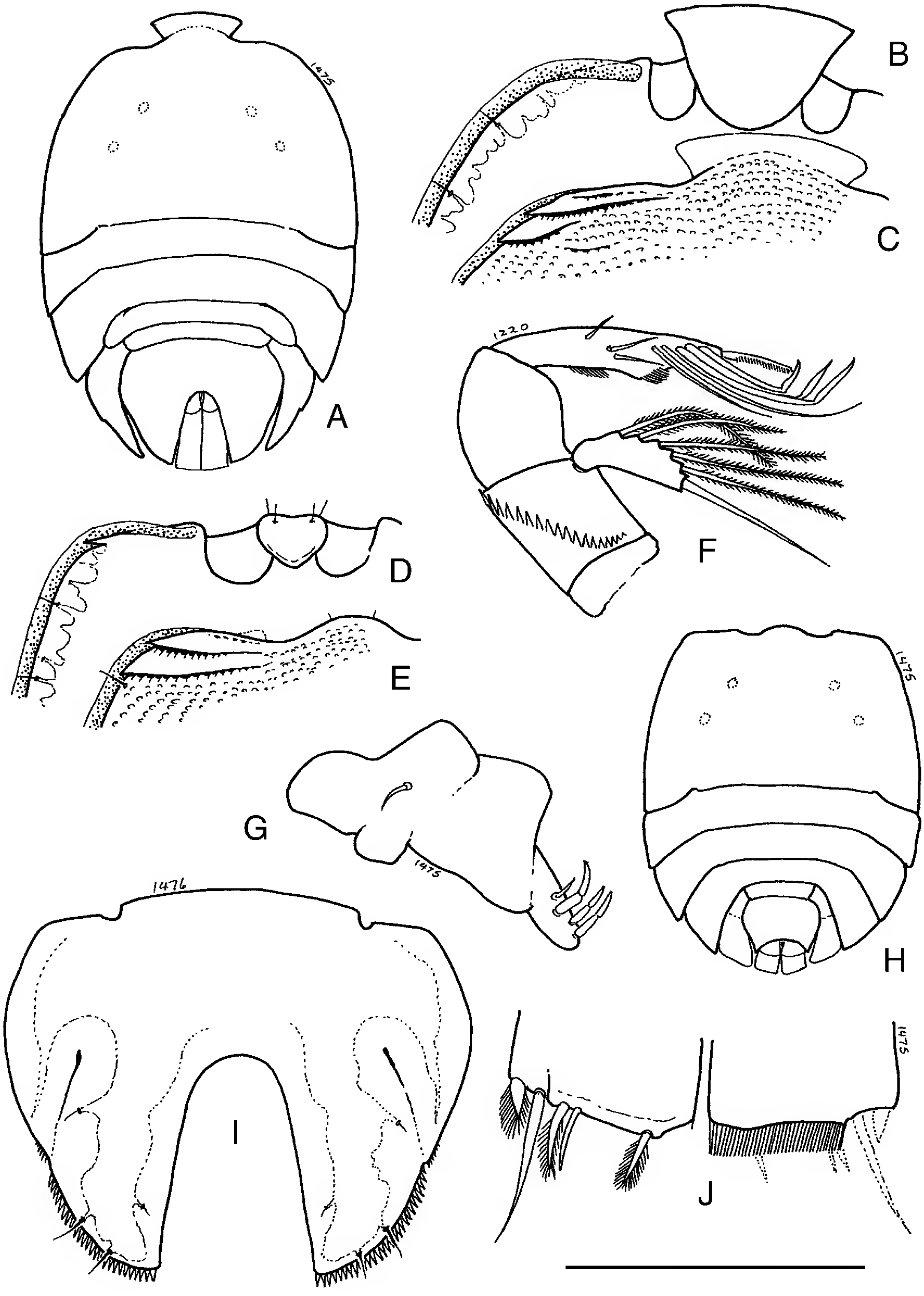

Figure 7. *Dilatatiocauda medialis* n.sp.: A, female. B, anterior of female cephalosome, ventral view (hyaline border stippled). C, same, dorsal view. D, anterior of male cephalosome, ventral view. E, same, dorsal view. F, antenna. G, maxilliped. H, male. I, female urosome, dorsal view. J, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,H = 0.6 mm; B,C,D,E = 0.3 mm; F = 0.1 mm; G,J = 0.08 mm; I = 0.225 mm.

Dilatatiocauda retroseta n.sp.

Figs. 3, 6, 9, 10

Type material. HOLOTYPE adult female without egg mass, length 0.94 mm. AM P58796. ALLOTYPE adult male, length 0.7 mm. AM P58797. PARATYPES AM P58802, 2♀♀, 2♂♂ + coupled ♂; BMNH 2000.1253–1254, 1♀, 1♂; NSM Tokyo Cr13416, 1♀, 1♂. Type material pooled from *Dictyopteris* sp., (49), plus *Sargassum* sp., (8), *Cystophora* sp., (2), *Ecklonia radiata* (8), infralittoral fringe rocks, Cronulla, Sydney (34°03'S 151°11'E), Australia, 12.2.77, V.A. Harris.

Material collected from Shelly Beach rocks, Cronulla, Sydney, New South Wales by V.A. Harris. 7.2.74, washed from *Sargassum* sp., 1♂. 21.8.75, *Dictyopteris* sp., 1♀, 2♂♂ + 2 coupled ♂♂. 17.2.77, *Dictyopteris* sp., 1♂ + 2 coupled ♂♂; *Sargassum* sp., 2♀♀; *Cystophora* sp., 2 coupled ♂♂; stones with coralline incrustation 1♂; *Ecklonia radiata* 4♀♀, 4♂♂; *Dictyopteris* sp., 21♀, 19♂ + 1 coupled ♂; *Sargassum* sp. with other weeds 2♀, 1♂ + 1 coupled ♂; *Sargassum* sp., 1♂.

Diagnosis. *Adult female*: dorsal ornamentation a network of ridges and oval areas of honeycomb, ventral surface of cephalosome wrinkled; sternal plate of metasome segment 4 fimbriate, not ridged; comb plates on labrum with many ridges (>8); caudal ramus elongate, rectangular (L/W = 3.2), α seta ⅔ down ramus, terminal setae all large, pinnate, seta T3 close to T2, seta T4 close to medial corner; geniculate setae of antenna long, J-shaped (twice length of endopod segment 2), terminal part curved, pectinate; lateral denticulate peg area on P1 endopod large (>½ endopod width), large medial peg area present; segments 2 & 3 of P4 endopod not fused; anterolateral edge of P5 exopod with chitinous striations. *Adult male*: aesthetasc on antennule with bulbous base, coupling denticles small; P2 endopod terminates in two plumose setae; P5 with rows of setules at the base of each terminal seta.

Dimensions. *Females*: mean length 0.93 mm (SD = 0.026, *N* = 20), cephalosome width 0.61 mm (SD = 0.019, *N* = 20), body length to width ratio 1.52. Rostrum width 0.12 mm (SD = 0.005, *N* = 20), ratio of body width to rostrum 5.1. Urosome width to length ratio 1.33. Caudal ramus length to width ratio 3.2, dilation index 7.3. *Males*: mean length 0.67 mm (SD = 0.019, *N* = 19), cephalosome width 0.53 mm (SD = 0.014, *N* = 19), ratio of body length to width 1.26.

Description. *Adult female* (Fig. 9A) pale yellow or colourless. Anterior outline of cephalosome semicircular, rostrum prominent. Scanning electron micrographs reveal a fine network of ridges covering the dorsal surface of the body (Plate 2A & B), several more prominent ridges run parallel to the anterior border of the cephalosome and in various directions elsewhere. Towards the mid-line, there are many oval areas in which the cuticle is raised up to form a network of ridges that resemble honeycomb (see Plate 2C & D). Ventral surface of cephalosome wrinkled (Fig. 9B). Numerous sensillae with basal collar are scattered over the dorsal surface, dorsal pits between ridges about 2 µm. Hyaline border, granular, 15 µm wide. Small patch of setules anterior to labrum, cuticle of labrum wrinkled, comb plates with numerous ridges (>8) (Fig. 10C). Sternal plate of metasome segment 4 with hair-like setules, no ridges. Urosome broad without lateral notch or cleft (Fig. 9K), boundary between anterior and posterior lobes not distinct, anterior lobe without marginal setules, posterior lobe with large marginal setules, one sensory seta on posterior border, medial corner square. Caudal arch very deep (60% of urosome length). Caudal ramus elongate, rectangular, expanded distally, dorsal surface with a few reticulate ridges (Fig. 6D). Alpha seta inserted distally (Hicks' index = 33%). Alpha and beta setae close together ($L/[\alpha-\beta] = 16.6$). Terminal setae T1,T2 & T4 large, equal in size, pinnate, seta T3 slender, close to T2, seta T4 close to medial corner (set in ⅛ of width), terminal fringe of fine setules (Fig. 9J).

Limbs typical of family. Antenna exopod with five plumulose setae plus spinous seta (Fig. 10A), basis and segment 1 of endopod with triangular setules along edge, segment 1 without seta, segment 2 with three lateral and six terminal setae, geniculate setae very long, J-shaped (longest about twice length of endopod segment 2), terminal section curved, pectinate (comb-like with one row of teeth), claw long, pectinate. Posterior lobe of mandibular palp has four bulbous pilose setae with wing-like expansion at their base (Fig. 10E), anterior lobe with small area of hair-like setules. Maxilliped coxal lobes reduced, widely separated in mid-line, edge fimbriate (Fig. 9D), basis not fimbriate, fimbriate process absent. First segment of P1 exopod with ridge parallel to edge (Fig. 3D), lateral denticulate peg area on endopod large (>½ endopod width), medial denticulate peg area along inner edge, striated band parallel to fimbriate crescent /-shaped. P3 (Fig. 10H), spinous seta on segment 2 of endopod serrulate, equal in length to endopod, J-shaped serrate spinous seta on segment 3 longer than endopod (1.2:1). Segments 2 & 3 of P4 endopod are not fused (Fig. 10B). P5 exopod lanceolate (Fig. 10F), four dorsal setae near apex (first very small), anterolateral border with 10 to 15 chitinous striations (Fig. 10G). Females with 6 to 9 eggs in ovisac (mode 8).

Adult male (Fig. 9F). Yellow or colourless. Truncated anterior border of cephalosome convex in mid-line, concave at either side, lateral angle of antennule socket prominent (Fig. 9G,H). Surface ornamentation as for female. Rostrum 0.07 mm wide, cephalosome width to rostrum ratio = 8. Caudal ramus short, rectangular (L/W = 1.25), setation similar to female (Fig. 10D). Coupling apparatus on antennule not conspicuous, one small denticle with fine denticulations and plumose seta (Fig. 10I,J), aesthetasc swollen near base, dactylus terminates in small projection, base of dactylus expanded (Fig. 10I,K). P2 endopod (Fig. 9E) with two plumose terminal setae. First seta on P5 with long row of ventral setules (>20), short row of setules at base of each remaining seta (Fig. 9I).

Remarks. *Dilatatiocauda retroseta* is the largest of the three species described from Australia and its general proportions closely resemble *D. dilatata* as figured by Hicks (1971). However, it is distinguished from the latter by the very low position of the α seta on the caudal ramus, very long J-shaped geniculate setae on the antenna, a curiously swollen aesthetasc on the male antennule and the absence of ridges on the sternal plate of metasome segment 4. The specific name refers to the position of the α seta (L. *retro* = backward, behind + *saeta* = bristle).

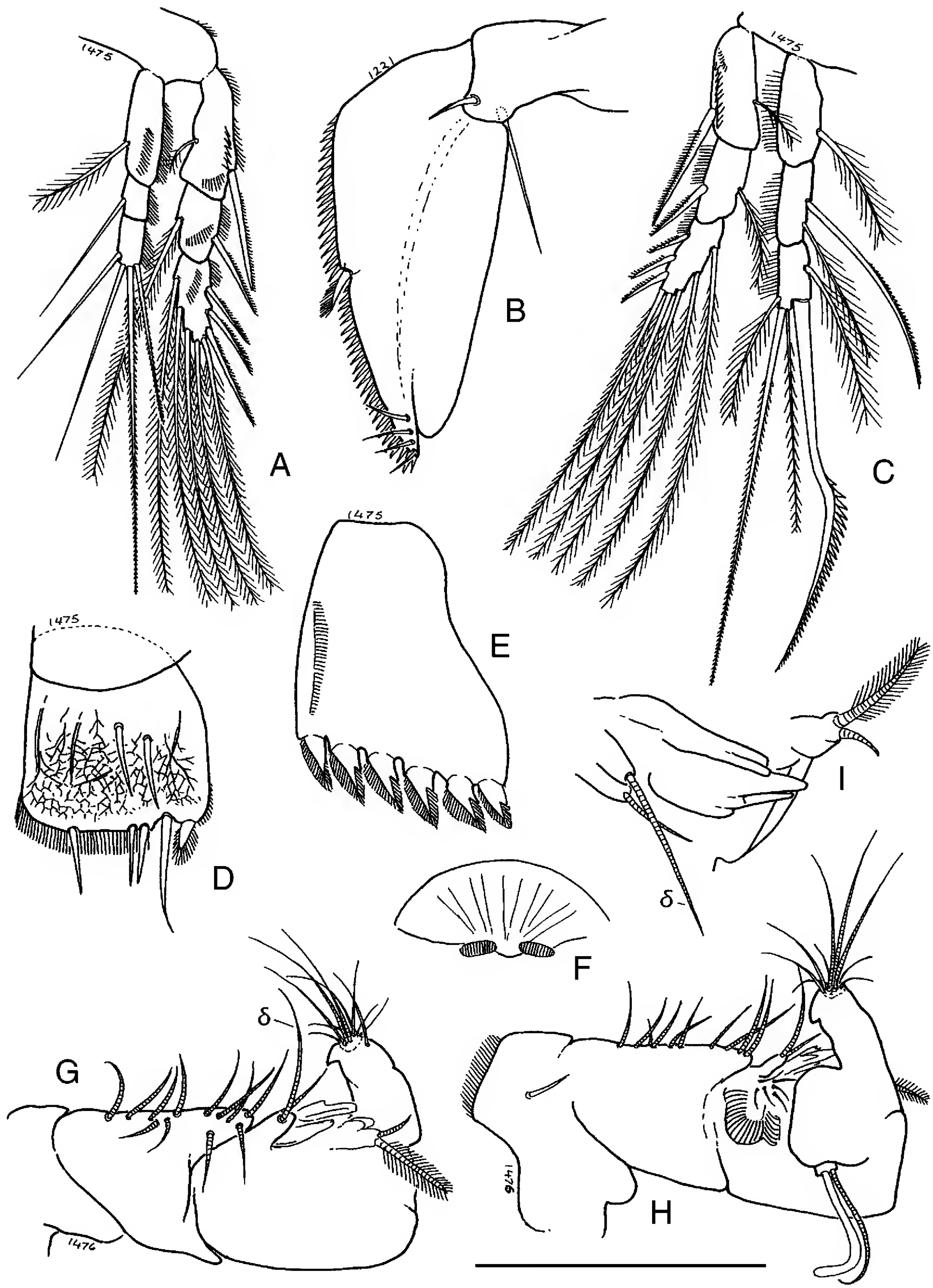

Figure 8. *Dilatatiocauda medialis* n.sp.: A, P4. B, female P5, dorsal view. C, P3. D, male right caudal ramus. E, male P5, ventral view. F, combs on labrum. G, male right antennule seen from dorsal side. H, left antennule, ventral view (dactylus obscures coupling denticles). I, coupling denticles, dorsal view. Scale bar: A,B,C = 0.15 mm; D = 0.08 mm; E,G,H = 0.1 mm; F = 0.133 mm; I = 0.06 mm.

This species shows a remarkable resemblance in many of its features to the animal described by Wiborg, 1964 as *Porcellidium tristanense*. Most striking is the similarity of the antennae. In both species the geniculate setae are J-shaped and about twice the length of endopod segment 2 (in *P. tristanense* the curved end piece has a double comb edge). Other similarities are the position of the α seta on the caudal ramus; a fimbriate border on the coxal lobe of the maxilliped; presence of denticulate pegs on the medial edge of P1 endopod; female P5 with chitinous striations on the anterolateral border and setules at the base of each terminal seta on male P5. Despite these resemblances, the

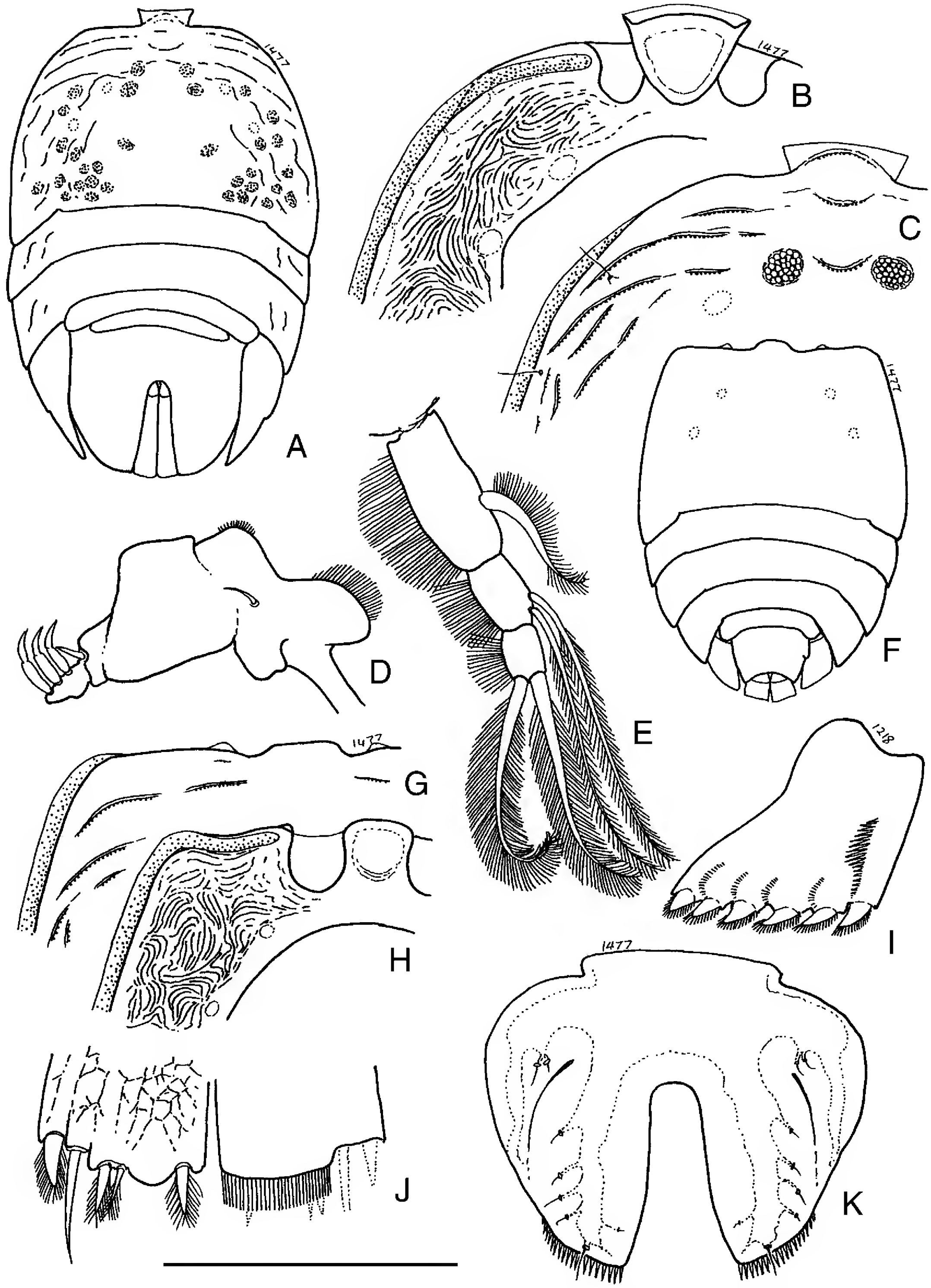

Figure 9. *Dilatatiocauda retroseta* n.sp.: A, female. B,C, anterior of female cephalosome (B, ventral view; C, dorsal view; hyaline border stippled). D, maxilliped. E, male P2 endopod. F, male. G,H, anterior of male cephalosome (G, dorsal focus; H, ventral focus). I, male P5, ventral view. J, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). K, female urosome, dorsal view. Scale bar: A,F = 0.6 mm; B,C,G,H,K = 0.3 mm; D,J = 0.08 mm; E = 0.15 mm; I = 0.133 mm.

species are distinct. The most important difference being the possession of four terminal setae on the male P2 endopod in *P. tristanense*, but only two in *D. retroseta*. The relationship of *P. tristanense* and *D. retroseta* will be considered further in the discussion.

Distribution and abundance. All specimens were collected at Cronulla, Sydney, New South Wales, where they were found associated with the more abundant *D. multidenticulata*. A small population was found on *Dictyopteris* sp. Isolated animals have been collected from *Sargassum* sp., *Ecklonia radiata* and *Cystophora* sp.

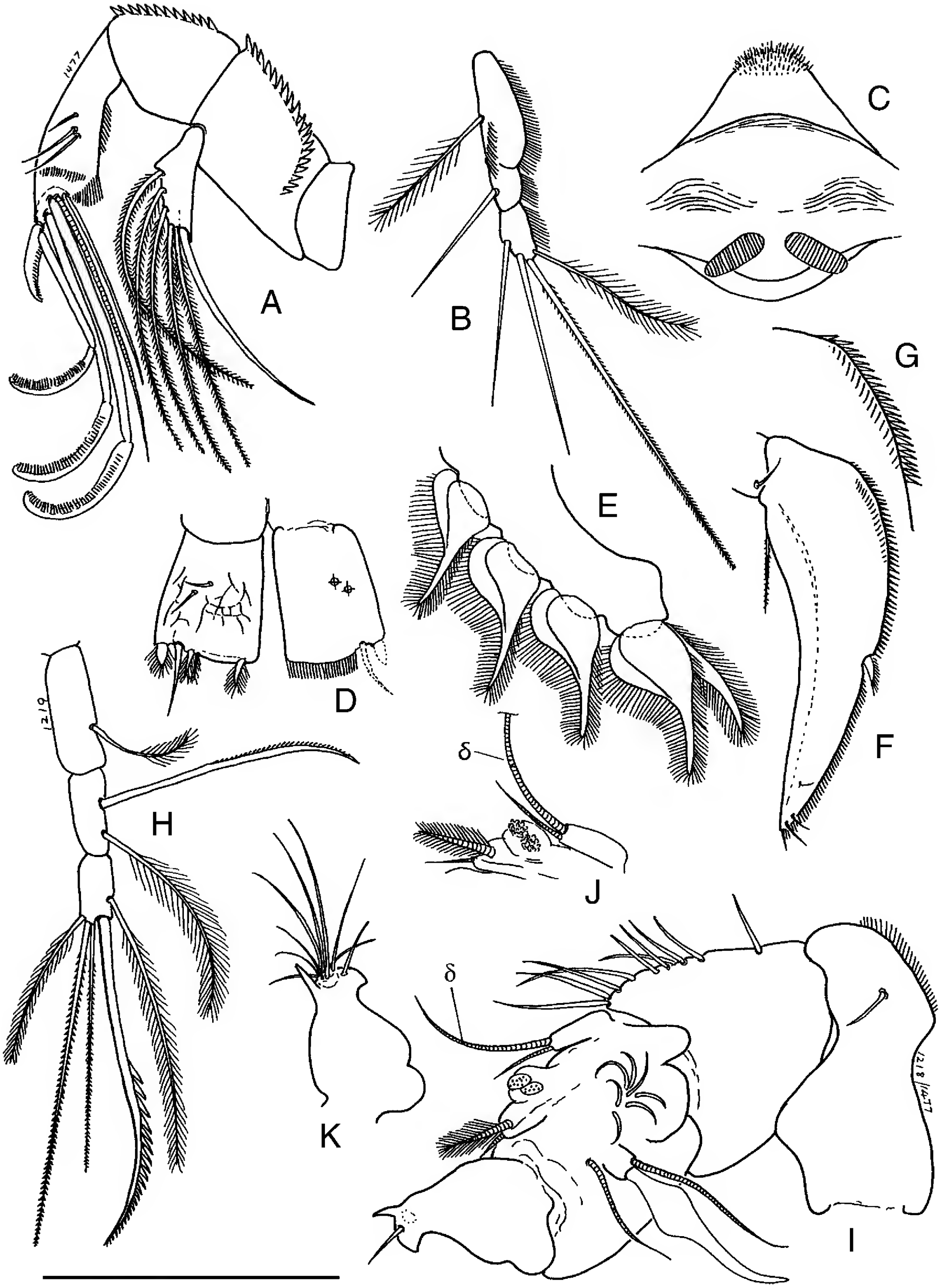

Figure 10. *Dilatatiocauda retroseta* n.sp.: A, antenna. B, P4 endopod. C, combs on labrum. D, male caudal rami. E, posterior lobe of mandibular palp showing wing-like expansion of pilose bulbous setae. F, female P5. G, striations on "shoulder" of P5. H, P3 endopod. I,J,K, male antennule (I, ventral view showing bulbous aesthetasc; J, detail of coupling denticles; K, dactylus). Scale bar: A = 0.125 mm; B,H = 0.15 mm; C,E,I,K = 0.1 mm; D,G = 0.133 mm; F = 0.225 mm; J = 0.08 mm.

Dilatatiocauda bipartita (Kim & Kim, 1997)

Figs. 3, 6, 11, 12

Porcellidium bipartitum Kim & Kim, 1997, 142–148, figs. 1–3.

Material examined. Specimens from Tei, Kochi Prefecture, Shikoku, Japan (33°32'N 133°45'E), (sample 951017) collected by N. Iwasaki: 30 adult ♀♀ (26 ovigerous), 11 adult ♂♂ (4 coupled with juvenile ♀), 6 ♂♂ + 4 ♀♀ copepodites, 88 nauplii. Specimens deposited at NSM Tokyo: ♀ Cr13412, ♂ Cr13413, 2 ♀♀ Cr13414; AM P58800, 1♀; BMNH 2000.1255–1256, 1♀, 1♂.

Diagnosis. *Adult female*: dorsal ornamentation of crescentic pits, no reticulate ridges or honeycomb structures, hyaline border granular; area of hair-like setules anterior to labrum, labrum with kidney-shaped area of denticulate setules in front of comb plates, comb plates with many ridges (>8); sternal plate of metasome segment 4 without fimbriate setules or ridges; caudal rami elongate, rectangular (length c. 3 × width), α and β setae not very close, α seta about ⅓ way down ramus, terminal seta T1 pinnate, setae T2, T3 and T4 plain, terminal fringe of 16 triangular setules; antenna with seta on segment 1 of endopod, geniculate setae not longer than segment 2 of endopod; maxilliped coxa with fimbriate border; lateral denticulate area on P1 endopod small (⅕ width of endopod), small medial denticulate area present; P4 endopod segments 2 and 3 fused, no chitinous striations along anterior-lateral border of P5. *Adult male*: dorsal pits and hyaline border as for female; terminal border of caudal ramus with numerous fine setules; antennule coupling denticles not denticulate, dactylus with terminal hook and single tooth; P2 endopod with two plumose terminal setae; P4 endopod segments 2 and 3 fused; P5 almost rectangular, setae pinnate lanceolate without row of setules at base.

Dimensions. *Females*: mean length (anterior of rostrum to posterior extremity of urosome) 1.45 mm (SD 0.047, N = 16), mean width of cephalosome 0.94 mm (SD = 0.026, N = 16), body length to width ratio 1.54. Rostrum 0.25 mm, ratio of body width to rostrum 3.76. Urosome width to length ratio 1.44. Caudal ramus length to width ratio 2.86, dilation index 8.2. (A single large female measuring 1.65 mm long, 1.07 mm wide and rostrum 0.027 was washed from *Chondrus giganteus* at Iwaya Port, Awajishima, Hyogo Prefecture, Japan, sample 980525/6, N. Iwasaki). *Males*: mean length 0.98 mm (range 0.97–1.0 mm, 5 animals), mean width 0.79 mm, (range 0.78–0.81 mm, 5 animals).

Description. *Adult female* (Fig. 11A). Pale yellow or colourless. Anterior of cephalosome semicircular, rostrum prominent (projects ⅓ of its width). Crescentic surface pits (2–3 µm diameter) near edge of cephalosome, on urosome, caudal rami and P5. Dorsal fold parallel to anterolateral edge of cephalosome (Fig. 11D). Hyaline border appears granular (22 µm wide). A pad of filiform setules lies anterior to the muscles of the labrum (Fig. 11C). A reniform (kidney-shaped) area of short denticulate setules lies anterior to comb plates on labrum, comb plates with more than 8 ridges. Sternal plate of metasome segment 4 without hair-like setules or ridges. Urosome broad (Fig. 11J), almost semicircular. No notch or cleft but scar indicates boundary between anterior and posterior lobes. Fine setules on distal half of anterior lobe. Posterior lobe wide, medial corner tightly rounded, fine setules along border which pass round medial corner into caudal arch (Korean specimens lack border setules). Two sensory setae present on posterior lobe, but set in from border. Caudal arch deep (58% of urosome length). Anal segment with two dorsal setae (Fig. 11J). Caudal rami (Fig. 6E) elongate, rectangular, sides almost parallel, terminal border between T3 and medial corner convex, short setules along posterior half of lateral and medial edges. Alpha seta medial (Hicks' index 62%, Korean animals 55%). Alpha and beta setae not very close ($L/[\alpha-\beta]$ = 7). Terminal seta T1 pinnate, setae T2 & T3 very close, plain, T4 plain, set in from medial corner (⅕ ramus width, Fig. 11G), terminal fringe of 16 large triangular setules. Limbs typical of family. Antenna exopod with five plumulose setae and one spinous plumulose seta. Basis and segment 1 of antenna endopod with U-shaped row of triangular setules (Fig. 12A), endopod segment 1 with small plain seta on anterior edge, endopod segment 2 with three lateral setae and six terminal setae, one plain, one long articulate plumulose seta (twice length of longest geniculate seta) and three plain geniculate setae which are shorter than segment 2, the claw is a long comb (as long as shortest geniculate seta). Posterior lobe of mandibular palp with wing-like hyaline expansions to base of the four bulbous setae (cf. Fig. 10E). Medial lobe of maxilliped coxa fimbriate (Fig. 11F). Lateral triangular area of denticles on P1 endopod small (⅕ width of endopod), small area of denticles on medial edge of endopod (Fig. 3E). Spinous seta on segment 2 of P3 endopod (Fig. 12B) strong, serrate, almost as long as endopod (0.9:1), J-shaped spinous seta on segment 3 serrate, longer than endopod (1.3:1), straight spinous terminal seta serrulate, much longer than endopod (1.6:1), internal and external seta on endopod segment 3 short plumose (Fig. 12C). P4 endopod segments 2 and 3 fused (i.e., endopod has only two segments, Fig. 12D), fused segment with three internal serrate spinous setae and long straight serrulate spinous seta. P5 basis with area of short setules on anterior edge (Fig. 11H), fringe of larger setules along posterior edge, dorsal seta plain, two ventral setae (one small plain seta plus longer plumulose seta, Fig. 11I), exopod ovo-lanceolate, anterolateral border without setules or chitinous striations, rest of border with setules. Apical seta present plus one large and two small dorsal setae (Fig. 11H). Females with 16 to 36 eggs in ovisac (mode 24, N = 18).

Adult male (Fig. 11B). Colour and surface pits as for female. Anterior of cephalosome truncated, shoulders sharply rounded with epaulet, lateral angle of antennule socket projects and is visible form above (Fig. 11E), rostrum narrow (0.075 mm), cephalosome width to rostrum ratio 10.6, rostrum does not project anteriorly. Crescentic pits near edge of cephalosome and on dorsal surface of caudal rami and P5s. Caudal ramus (Fig. 12G) short (L/W = 0.9), lateral edge convex, dilation index = 45, fine setules along posterior half of medial and lateral edges, terminal fringe of numerous fine setules, setation as for female except for terminal border. Antennule (Fig. 12I), anterior lobe and δ seta lie parallel to anterior edge of compound segment, δ seta projects laterally (not anteriorly). Three coupling denticles are present, they appear to be folded with a finely ridged or crenulated edge, there are two associated articulate plumose setae. Two long strap-like setae bordered with very short plumulae (marked * on Fig. 12I) are found on the ventral surface of the compound segment, one originates among the π setae, the origin of the other is obscured by

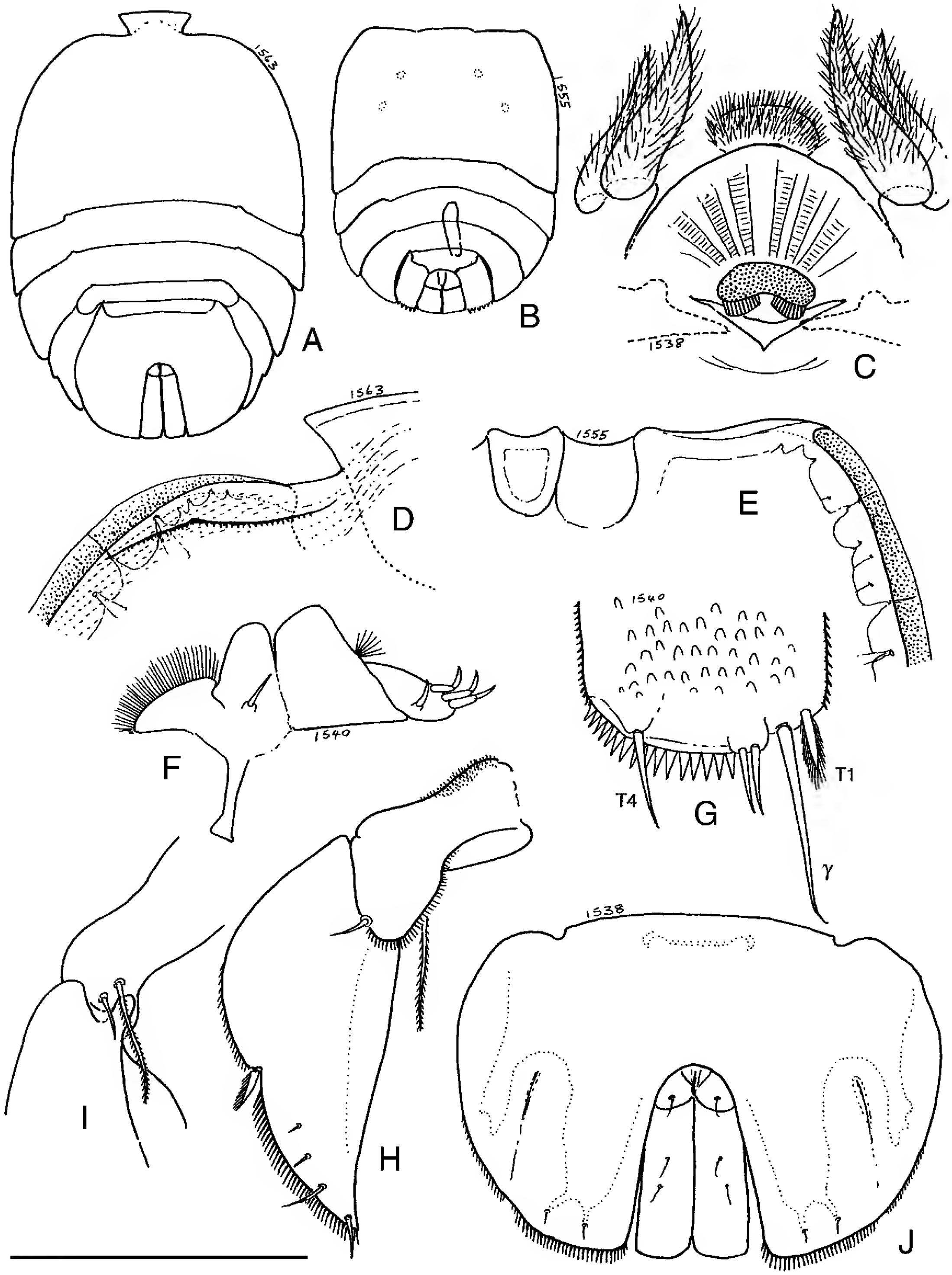

Figure 11. *Dilatatiocauda bipartita* (Kim & Kim, 1997): A, female. B, male. C, labrum showing anterior pad of filiform setules, reniform area of denticulate setules and comb plates. D, anterior of female cephalosome, dorsal view (hyaline border stippled). E, anterior of male cephalosome, ventral view. F, maxilliped. G, detail of terminal setae on female caudal ramus. H, female P5, dorsal view. I, female P5 detail of ventral setae. J, urosome plus caudal rami, showing dorsal setae on anal segment. Scale bar: A,B = 1.0 mm; C = 0.17 mm; D,E = 0.3 mm; F = 0.15 mm; G = 0.25 mm; H,I = 0.225 mm; J = 0.34 mm.

the proximal coupling denticle. Their appearance is unique and suggests that they may be sensory structures (Tiemann (1977) illustrates a similar flat seta on his *P. planum*). A chitinous ventral process or blade is present. The aesthetasc is short (not longer than the dactylus), it does not have a bulbous base. The dactylus has a large basal lobe, a tooth on the lateral edge and a strongly hooked apex (Fig. 12H). Endopod of P2 with two plumose terminal setae (Fig. 12F). P3 and P4 as for female, P4 with segments 2 and 3 fused. P5 (Fig. 12E) almost rectangular, terminal setae pinnate

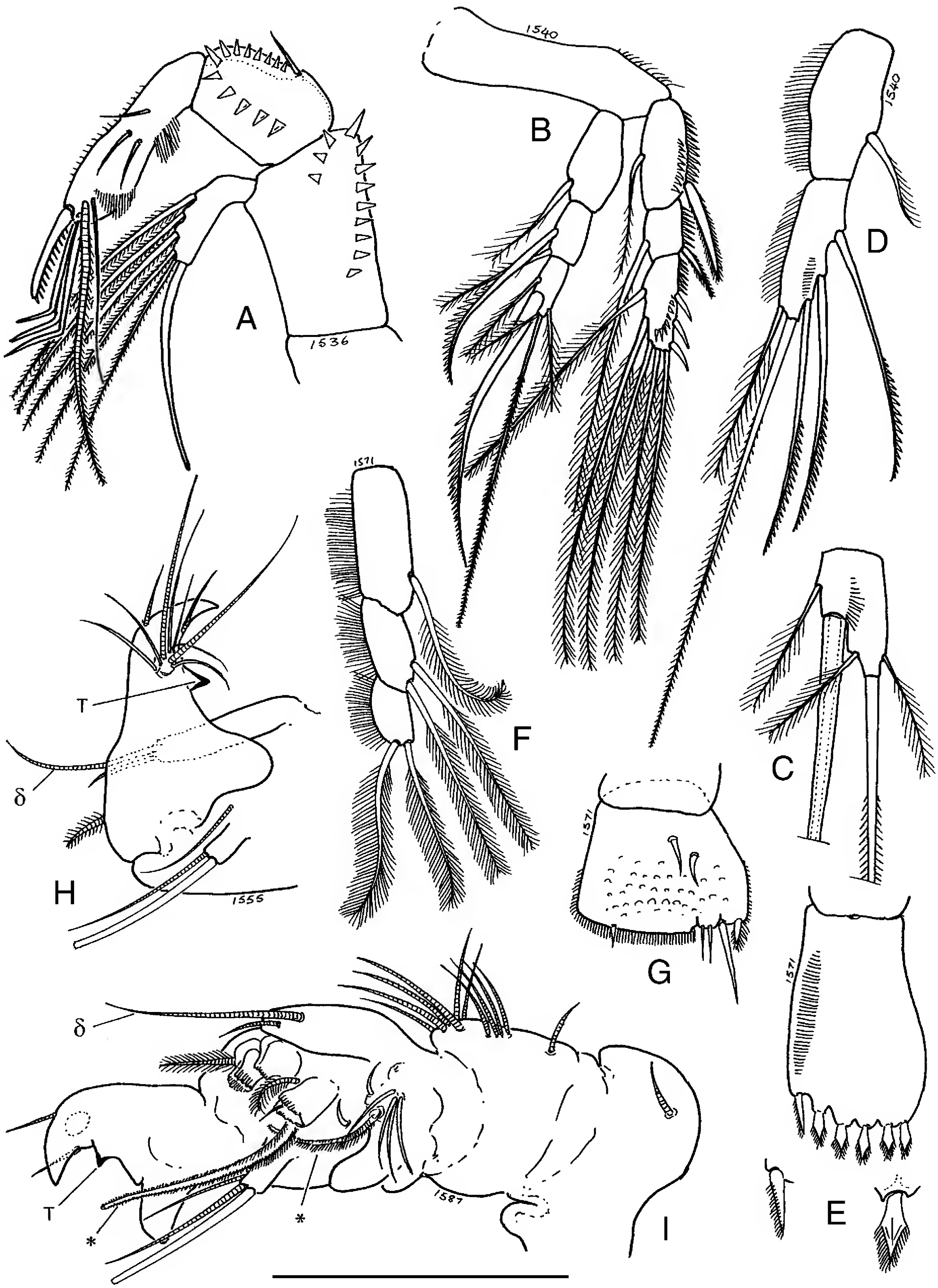

Figure 12. *Dilatatiocauda bipartita* (Kim & Kim, 1997): A, antenna, dorsal view showing seta and surface setules on segment 1 of endopod. B, P3. C, P3, detail of terminal segment of endopod. D, P4 endopod, showing fusion of segments 2 and 3. E, male P5 and enlargement of setae 1 and 6. F, male P2 endopod. G, male right caudal ramus. H, dactylus of male antennule in adducted position (ventral view). I, right male antennule (ventral view) with dactylus fully abducted to show coupling denticles. (T, tooth; δ, delta seta on anterior lobe; * strap-like plumulose setae). Scale bar: A,H = 0.133 mm; B = 0.25 mm; D,E,G = 0.15 mm; F = 0.225 mm.

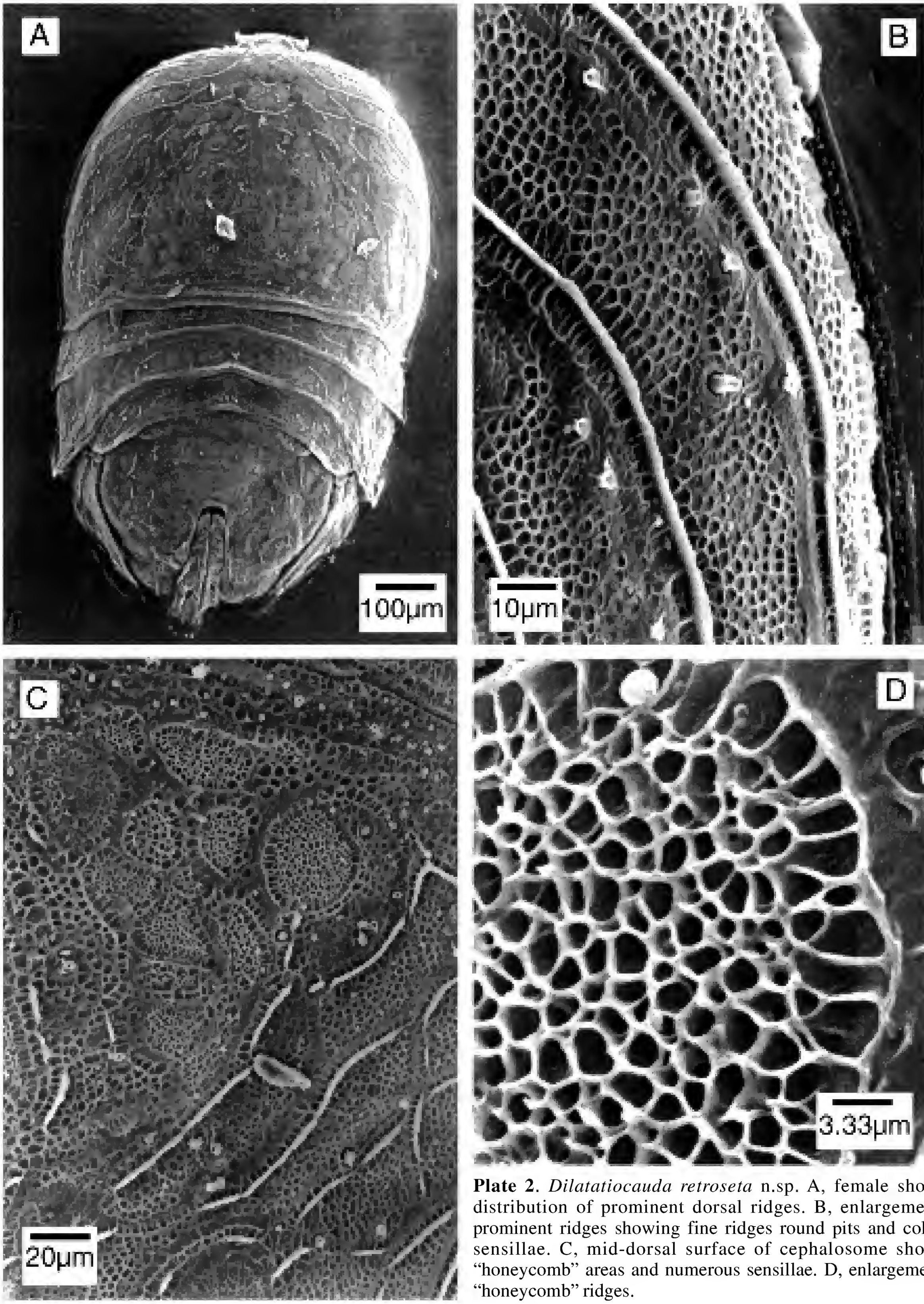

Plate 2. *Dilatatiocauda retroseta* n.sp. A, female showing distribution of prominent dorsal ridges. B, enlargement of prominent ridges showing fine ridges round pits and collared sensillae. C, mid-dorsal surface of cephalosome showing "honeycomb" areas and numerous sensillae. D, enlargement of "honeycomb" ridges.

lanceolate, long row of ventral setules (>20) associated with first (lateral) seta, no setule rows at base of other setae.

Remarks. *Dilatatiocauda bipartita* is unique among the Porcellidiidae in having only two segments to the endopod of the fourth peraeopod in both male and female animals, a fact indicated in the specific name. It is the largest species recorded for the family. Animals from Japan appear to be smaller than those from Korea. Kim & Kim (1997) only give a single measurement for length (♀ = 1.71 mm) without

indicating either the range of variation or the mean value for the population. The mean length of Tei females is 1.45 mm (SD = 0.047, N = 16), but a single female from Awajima measured 1.65 mm in length.

Kim & Kim (1997) state that the second limb (P2) endopod of male animals terminates with 2 or 3 setae. Data is not given as to the frequency of the 3-seta condition in the population, nor is it stated which of the four setae found in females has been lost. All Japanese specimens have only two plumose terminal setae on the male P2 endopod and this must be considered the normal condition.

Dilatatiocauda bipartita shows a remarkable resemblance to the animal described by Tiemann (1977) as *Porcellidium planum*. The two animals share the following unique features: the antennule of males have two long strap-like plumulose setae and similarly shaped dactylus; antennae have an anterior seta on endopod segment 1; the coxa of maxilliped is fimbriate and the area of denticulate pegs on P1 endopod is similar; the unusual shape and setation of P3 endopod and male P5 are virtually identical. However, the following significant differences show that the two species are distinct: *P. planum* has the α seta on caudal ramus proximally situated and very close to β (L/[α–β] = 35); the maxilliped basis has a fimbriate border; the terminal segment of male P2 has four setae (one spinous, three plumose); segments of P4 endopod are not fused (there are three segments). The significance of these differences will be considered in the discussion.

Distribution. Animals collected by N. Iwasaki at Tei, Kochi Prefecture were washed from *Ecklonia cava*. A single female was found in washings from *Chondrus giganteus* collected at Iwaya Port, Awajishima, Hyogo Prefecture. The species has also been collected from *Ecklonia cava* at Chojagasaki, Kanagawa Prefecture by Yuka (Tadasugi) Sasaki and at Hamajima, Mie Prefecture by Hiroshi Ito (specimens in possession of Yuka (Tadasugi) Sasaki examined by author). Despite extensive sampling at Kadonohama Bay, Ofunato, Iwate Prefecture, *D. bipartita* has not been found there. This suggests that it is a southern species distributed along the southern coast of Honshu, Shikoku and in the Korea Strait.

Discussion

The family Porcellidiidae has long been regarded as monotypic with one genus, *Porcellidium*. Huys *et al.*, (1996) have emphasised this point of view by making the diagnosis of the genus *Porcellidium* identical to their diagnosis of the family. They rejected new genera proposed by Harris (1994) and Harris & Robertson (1994), "… on the grounds that creation of new genera should wait a revision of the type-genus *Porcellidium*", Bodin (1997). The validity of this point of view and justification for establishing the new genus *Dilatatiocauda* need to be considered.

Table 1. Comparison between *Dilatatiocauda* species

	characters	*dilatatia*	*multidenticulata*	*medialis*	*retroseta*	*tristanensis*	*plana*	*bipartita*
1	**caudal ramus**							
	Hicks' Index for α seta	H = 73%	H = 80%	H = 55%	H = 33%	H = 38%	H = 68%	H = 62%
	setules on lateral and medial edge	absent	absent	absent	absent	present	present	present
2	**male antennule**							
	lobe to dactylus	yes	yes	yes	yes	no	yes	yes
	2 strap-like plumulose setae	absent	absent	absent	absent	absent	?present	present
3	**antenna**							
	seta on segment 1 of endopod	no	no	no	no	no	yes	yes
	longest geniculate seta on segment 2 of endopod	= seg 2 length	= seg 2 length	= seg 2 length	2 × seg 2 length	2 × seg 2 length	= seg 2 length	< seg 2 length
	shape of geniculate setae	L-shaped	L-shaped	L-shaped	J-shaped pectinate	J-shaped pectinate	L-shaped	L-shaped
4	**P1**							
	lateral denticulate area	large (> ½ width)	large (> ½ width)	small (< ½ width)	large (> ½ width)	large (> ½ width)	small (< ½ width)	small (½ width)
	medial denticulate area	absent	absent	absent	present	present	absent	present
5	**male P2**							
	terminal setae	2 setae	2 setae	2 setae	2 setae	4 setae	4 setae	2 setae
6	**male P5**							
	setules at base of terminal setae	present	absent	absent	present	present	absent	absent

Three strong reasons for accepting more than one genus in the family can be given. Firstly the number of known species (either published or studied in considerable detail by the author) now exceeds 70. This provides a greatly expanded data base and deeper insight into the range of characters available for taxonomic study. Many new structures have been found which add weight to the opinion that the family embraces more than one genus.

Secondly, judging from the characters chosen by Huys *et al.*, (1996), their diagnosis of the family appears to be based primarily on the European species and excludes many species from other parts of the world. For example, *Porcellidium ravanae* Thompson & Scott, 1903, *P. clavigerum* Pesta, 1935, *P. tristanense* Wiborg, 1964, *P. trisetosum* Geddes, 1968, *P. planum* Tiemann, 1977, *P. laurencium* Hicks, 1982, *P. ulvum* Hicks, 1982, *Murramia magna* Harris, 1994, *M. bicincta* Harris, 1994 and *Kioloaria sesquimaculata* Harris, 1994 are all excluded from *Porcellidium* on the number of terminal setae found on the male P2 endopod. *Porcellidium unicus* Ummerkutty, 1970, is excluded on the number of setae on the male P5 exopod. Other species are excluded for different reasons. This problem can be solved in two ways. Either the misfits are moved to new families or the family is redefined to include new genera for those species that do not fit *Porcellidium*.

Splitting off some species into new families does not seem justified. Members of the Porcellidiidae are highly specialized for dwelling on the surface of seaweeds in the littoral and sub-littoral zones where they are subject to severe wave movement. All species are remarkably similar in shape and structure and no major differences have been found that would suggest the Porcellidiidae should be split into several families.

Thirdly, several clearly defined species groups have been found in which members share a cluster of unique (apomorphic) characters that are not fond elsewhere in the Porcellidiidae. Hicks (1982) was the first to point out that *Porcellidium clavigerum*, *P. echinophylum* Humes & Gelerman, 1962, *P. laurencium* and *P. ulvum* form a natural group, the "clavigerum complex", which is characterised by lateral striations on the female urosome and caudal rami with four equally spaced clavate terminal setae. Hicks' "clavigerum complex" was raised to generic status as *Clavigofera* Harris & Iwasaki, 1996b with the addition of another species from Japan and Australia.

Other "complexes" have been described. Two species from Australia possess an unusual modification in which the lateral edge of the cephalosome is reflexed ventrally. This has resulted in loss of the true hyaline border and migration of the eight border sensillae to the underside of the carapace. Ducts from the marginal glands, which open dorsal to the hyaline border in all other species, now open ventrally. These undoubted apomorphic characters, together with other peculiarities, form a character set that is unique and justifies generic status. These species were placed in the genus *Tectacingulum* Harris, 1994, (L. *tectus* = hidden + *cingula* = a girdle).

Another "species complex" comprises three species from Japan and one from Australia in which the male antennule bears a "comb" on the anterior edge of the compound segment. They are further characterised by pentagonal caudal rami and a ventral fold on the female P5 exopod that lies under the edge of the urosome. Again, these features appear good apomorphic characters and, together with other unique features, constitute a character set that defines this "complex". It has been given the generic name *Kushia* Harris & Iwasaki, 1996b (derived from the Japanese *kushi* = a comb).

The new species described in this paper are distinguished from all other members of the Porcellidiidae by the unique structure of their maxillipeds. This, together with other unusual features described, provide an unique set of apomorphic characters that define another discrete group of species for which the generic name *Dilatatiocauda* seems justified.

Huys *et al.*, (1996) rejected Australian genera proposed by Harris (1994) and Harris & Robertson (1994), in the belief that they were "based on dubious grounds". In the case of *Kioloaria* and *Brevifrons* Harris, 1994, their criticism may be justified because only one species is presently known in each of the proposed genera. However, in the case of *Tectacingulum, Kushia* and *Dilatatiocauda*, the set of diagnostic characters chosen to define the new genera were discovered on single species in the first instance. In each case a new species had been found that possessed several unique features, unknown elsewhere in the family. This suggested the existence of a new group or complex. At a later date this was confirmed when other new species were found that possessed the same unique character set.

Selection of a character set from a single species to define a new complex is highly subjective. It is based upon the belief that the unique characters chosen are apomorphic and beyond the range of trivial variations that distinguish species. Such beliefs will be confirmed (and the erection of new genera justified) if and when new species are discovered that possess the same character set. An example of this is given by *Kensakia* Harris & Iwasaki, 1997. The genus was created to accommodate a single species from Kadonohama Bay, Ofunato, Japan. Since publication, two new species (not yet described) have been discovered (one from Japan and another from Queensland, Australia) that possess the same character set and, therefore, belong to *Kensakia*. This demonstrates that creating new genera on the strength of a single species may be justified provided suitable apomorphies can be recognised.

Erecting new genera should not prejudice or interfere with a revision of the type genus, *Porcellidium* for, by definition, they will be based on characters that *Porcellidium* does not share.

Unfortunately, all early descriptions of species paid little attention to male animals even though males display many valuable taxonomic features. Indeed, in cases where distinguishing between females of two different species is difficult or impossible, males show clear-cut differences that allow immediate and positive identification.

The adult male antennule is of particular importance in identification. Hicks (1982) was the first to suggest that this organ might be of taxonomic value. Harris (1994) compared the setation of male and female copepodites and studied the changes that occur during metamorphosis to the adult. He showed that several chitinous structures (referred to as coupling denticles) arise *de novo* at the time of the male's final moult and are species specific. At that time they were not regarded as useful for identification because they are difficult to see when the dactylus is in the adducted position, but better techniques have enabled this important

organ to be studied in detail. Besides the wide range of species-specific coupling structures found, it was discovered that the male antennule may show apomorphic characters. This was first demonstrated in the genus *Kushia*, but it has now been confirmed for *Murramia* and *Tectacingulum*—Harris (1994), *Clavigofera* and *Kensakia*—Harris & Iwasaki (1996b, 1997), and *Dilatatiocauda* . Structure of the male antennule, together with other male characters, should play a major role in future descriptions of new species and revision of the Porcellidiidae.

Two previously described species, *Porcellidium tristanense* Wiborg, 1964 and *P. planum* Tiemann, 1977, possess many of the characteristics of *Dilatatiocauda*, but differ in one important feature: both species have four terminal setae on the male P2 endopod. Females of all species within the Porcellidiidae have four terminal setae on the P2 endopod, but male animals have either two or three setae. The five species of *Dilatatiocauda* described above all have two terminal setae. Hicks (1982) considered the possession of four setae on the male P2 of *P. tristanense* a primitive condition and regarded it as a plesiomorphic character. The same argument might be applied to *P. planum*. This explanation clears the way for these two species to be included in *Dilatatiocauda* as *D. tristanensis* (Wiborg, 1964) and *D. plana* (Tiemann, 1977).

Although *D. tristanensis* and *D. plana* have the same unique setation of the male's P2, they share few other similarities. Table 1, gives a comparison of several characteristics between the species of *Dilatatiocauda*. *Dilatatiocauda plana* shares many more features with *D. bipartita* than other species, *D. retroseta* and *D. tristanensis* closely resemble each other, and *D. multidenticulata* and *D. dilatata* are very similar. These striking similarities reinforce the idea that all are closely related and should be included in the same genus.

ACKNOWLEDGMENTS I wish to thank Dr S. Stowe, Australian National University Electron Microscope Unit for her helpful advice and assistance whilst studying specimens with the Hitachi S-255 scanning electron microscope; Dr Nozomu Iwasaki for allowing me to work on *Dilatatiocauda bipartita* material from Shikoku, Japan and specimens of the species from other parts of Japan, also for his helpful comments and corrections to the manuscript; Dr Hicks for paratype specimens of *Porcellidium dilatatum* from Wellington and Yuka (Tadasugi) Sasaki for allowing me to examine her specimens of *D. bipartita*, *Kensakia* sp., and other Japanese material. I am grateful to the referees of this paper for their constructive comments, corrections and criticism.

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Manuscript received 16 June 2000, revised 8 January 2001 and accepted 19 February 2001.

Associate Editor: G.D.F. Wilson.

Records of the Australian Museum (2002) Vol. 54: 25–30. ISSN 0067-1975

A New Species of the Freshwater Crayfish Genus *Euastacus* (Decapoda: Parastacidae) from Northeastern New South Wales, Australia

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ABSTRACT. A new species of the freshwater crayfish genus *Euastacus, E. mirangudjin*, is described from northeastern New South Wales. The species most closely resembles *E. reductus* Riek 1969, differing in spination of the chelae and in colouration. The species is recorded only from the type locality, in Toonumbar National Park, where it inhabits the rocky edges of Iron Pot Creek.

COUGHRAN, JASON, 2002. A new species of the freshwater crayfish genus *Euastacus* (Decapoda: Parastacidae) from northeastern New South Wales, Australia. *Records of the Australian Museum* 54(1): 25–30.

The genus *Euastacus* was erected by Clark (1936), separating the spiny crayfishes of the Australian mainland from those of the Tasmanian genus *Astacopsis*. Species of *Euastacus* have been described by a number of authors, the main taxonomic works having been undertaken by Clark (1936, 1941), Riek (1951, 1956, 1969) and Morgan (1986, 1988, 1997). The genus *Euastacoides* Riek was synonymised with *Euastacus* by Morgan (1988).

Five specimens of *Euastacus mirangudjin* n.sp. were caught on 6 September 2000 during a research project on *Euastacus gumar* Morgan 1997, on the eastern side of the Richmond Range in northeastern New South Wales (Fig. 1). The new species was not found at 27 other locations sampled (all within ≈50 km of the type locality), although the majority of these were on the western side of the Richmond Range. The specimens were caught in an area within the known distribution of two other species of *Euastacus, E. sulcatus* Riek 1951 and *E. valentulus* Riek 1951. However, no other species of crayfish was captured at the site where the new species was found. The specimens of this new species were immediately recognisable as being different from the above species in both morphology and colouration. Two specimens were retained and preserved, and the other three released alive at the site of capture. Morphological details were recorded for the two specimens preserved and two of the three specimens released. The third specimen released was much smaller than the others (<15 mm occipital carapace length [OCL]) and was not subjected to the same detailed examination. The four specimens examined in detail were between 26 mm and 37 mm OCL. The largest specimen collected (37 mm OCL), a berried female, was released.

The specimens collected could not be identified with the most recent key to the genus (Morgan, 1997), either collectively or individually. The large number of distinguishing features, including several features integral to the identification of species in the genus *Euastacus*, warrant the recognition of the specimens as a new species of this genus. This species most closely resembles *E. reductus* (from central eastern New South Wales). The species is easily distinguished from other species of *Euastacus* from northeastern New South Wales, which are generally larger and/or spinier. Character states and ratios are as used by Morgan (1986, 1997).

Euastacus mirangudjin n.sp.

Fig. 2–4

Type material. HOLOTYPE: female (30 mm OCL); Iron Pot Creek, Toonumbar National Park, rainforest; 28°28'30"S 152°45'E; elevation 560 m; 6 September 2000; collected by Jason Coughran and Benjamin Black, lodged with the Australian Museum (AM P61072). PARATYPE: male (34.5 mm OCL), lodged with the Australian Museum (AM P61073).

Type locality. The type locality is in Iron Pot Creek, an upper tributary of the Richmond River, approximately 30 km NW of Kyogle (28°28'30"S 152°45'E). The site is approximately 500m upstream of the junction of Murray Scrub Management Trail and Iron Pot Creek. The site is in the rainforest of Toonumbar National Park, at an elevation of 560m. The stream where the specimens were collected was up to 10 metres in width and 1 metre in depth. Water temperature was 9°C and pH 6.65 (recorded at 3:00 PM on 6 September 2000).

Other specimens examined. Two other specimens (26 mm OCL ♀; 37 mm OCL ♀) caught at the type locality were also examined before being released. Ratios used in the description are based on the retained specimens only.

Diagnosis. Male cuticle partition present. Rostrum short, just reaching base of third antennal segment. 3 rostral spines per side, extending beyond midlength of rostrum. Antennal squame without marginal spines. Suborbital spine small to medium. Dorsal thoracic spines absent/barely discernible. Cervical spines barely discernible or small. 1–5 small and sharp Li spines on somite 2, 1 barely discernible or absent on other somites. D spines and abdominal boss absent. Telsonic and uropodal marginal spines absent. 4–7 spines above the propodal cutting edges extending to base of chela gape, and 3–4 spines above the dactylar cutting edges. 3–4 dorsal apical propodal spines. 1 apical mesial dactylar spine. Dactylar basal spines absent. Ventrolateral propodal spine row either absent or poorly developed into a single, blunt spine at midlength. Usually 3 mesial carpal spines. 1 poorly developed lateral carpal spine at distal edge of carpus (rarely two spines). Ventral carpal spine large. One ventromesial carpal spine.

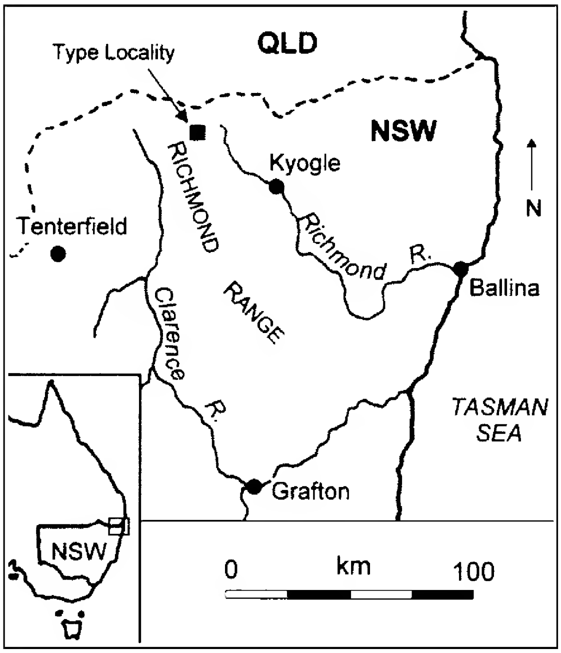

Figure 1. Collection locality of *Euastacus mirangudjin* n.sp.

Figure 2. *Euastacus mirangudjin* n.sp. Dorsal view, holotype. Photograph by Max Egan.

Description. Maximum OCL 37 mm. *Rostrum*—short, just reaching base of third antennal segment, with a distinct and deep longitudinal groove; rostral margins parallel at sides and divergent at base; rostral carinae short; 3 marginal rostral spines per side, extending beyond midlength of rostrum (paratype with 2 spines on one side); acumen spine similar in size to marginal spines; OCL/carapace length = 0.88; rostral width/OCL = 0.14–0.17. *Cephalon*—weakly spinose; antennal squame marginal spines absent; 1st postorbital ridge spine small to medium, 2nd postorbital ridge spine barely discernible (ridge reduced to a subtle bump on carapace); numerous small to medium, blunt cephalic spines ventral to postorbital ridges; suborbital spine small to medium in size; interantennal scale of medium width and scalloped; basipodite spine absent or small; coxopodite spine small to medium and occasionally bifid; interantennal scale length/OCL = 0.09–0.1. *Thorax*—1–5 cervical spines per side, barely discernible or very small; thoracic spines absent or barely discernible; general tubercles dense and small; areola length/OCL = 0.35; areola width/OCL = 0.13–0.14; carapace width/OCL = 0.53–0.55; carapace depth/OCL = 0.47–0.54. *Abdomen*—1–5 Li spines on somite 2, 1 barely discernible or absent on other somites;

Figure 3. *Euastacus mirangudjin* n.sp. Dorsal view of chela (paratype) showing 4 mesial carpal spines. All other specimens examined bore 3 mesial carpal spines. Photograph by Max Egan.

2 Lii spines on somite 2 of large female specimen (released) (OCL 37 mm); D-L spines absent on most specimens, although present and minute on large female; D spines and abdominal boss absent; abdomen width/OCL = 0.5–0.52; OCL/total length = 0.42. *Tailfan*—telsonic and uropodal marginal spines absent; telson length/OCL = 0.33. *Chelae*—elongate. *Dactylus*—dactylar basal spines absent; 1 apical mesial dactylar spine; 3–4 medium to large and blunt spines above dactylar cutting edge, extending to midlength of chela gape (apical on paratype); dactylar length/propodal length = 0.55. *Propodus*—5 mesial propodal spines; ventrolateral propodal spines absent or poorly developed into a single blunt spine at midlength of propodus; dorsolateral propodal spines reaching apex but not base of propodus; 3–4 apical propodal spines; 4–7 small to large and blunt spines above propodal cutting edge, extending to base of chela gape; few to numerous protuberances lateral to dactylar base dorsally, two specimens also with 1 or 2 spines (on one chela only); usually 1 (rarely 2) spines lateral to dactylar base ventrally; 2 spines ventral to propodal cutting edge proximal to midlength; spines posterior to dactylar articulation absent; 2 spines at dactylar articulation both dorsally and ventrally; propodal length/OCL = 1.0–1.03; propodal width/propodal length = 0.42; propodal depth/propodal length = 0.27–0.28. *Carpus*—dorsal groove deep; lateral carpal spination poorly developed into a single blunt spine at distal edge of carpus (one specimen with two discernible spines on one chela); usually 3 mesial carpal spines, paratype with 4 large and distinct spines on one chela and 2 large and 2 small (but distinct) spines on other chela (Fig. 3); dorsal carpal spines absent; ventral carpal spine large; ventromesial carpal spine as large as, or larger than, ventral spine on specimens >30 mm OCL, smaller than ventral spine on specimens 30 mm OCL and smaller; dorsal carpal groove present. *Merus*—7–8 small to large dorsal spines. *Keel*—*Pr.1*, close and parallel; *Pr.2*, apart and parallel to slightly closed; *Pr.3*, apart and of narrow to moderate breadth, scoops absent; *Pr.4*, apart and very broad, anterior margin rounded, posterior margin convex. *Setation*—moderate. *Punctation*—moderate on cephalon, denser on thorax.

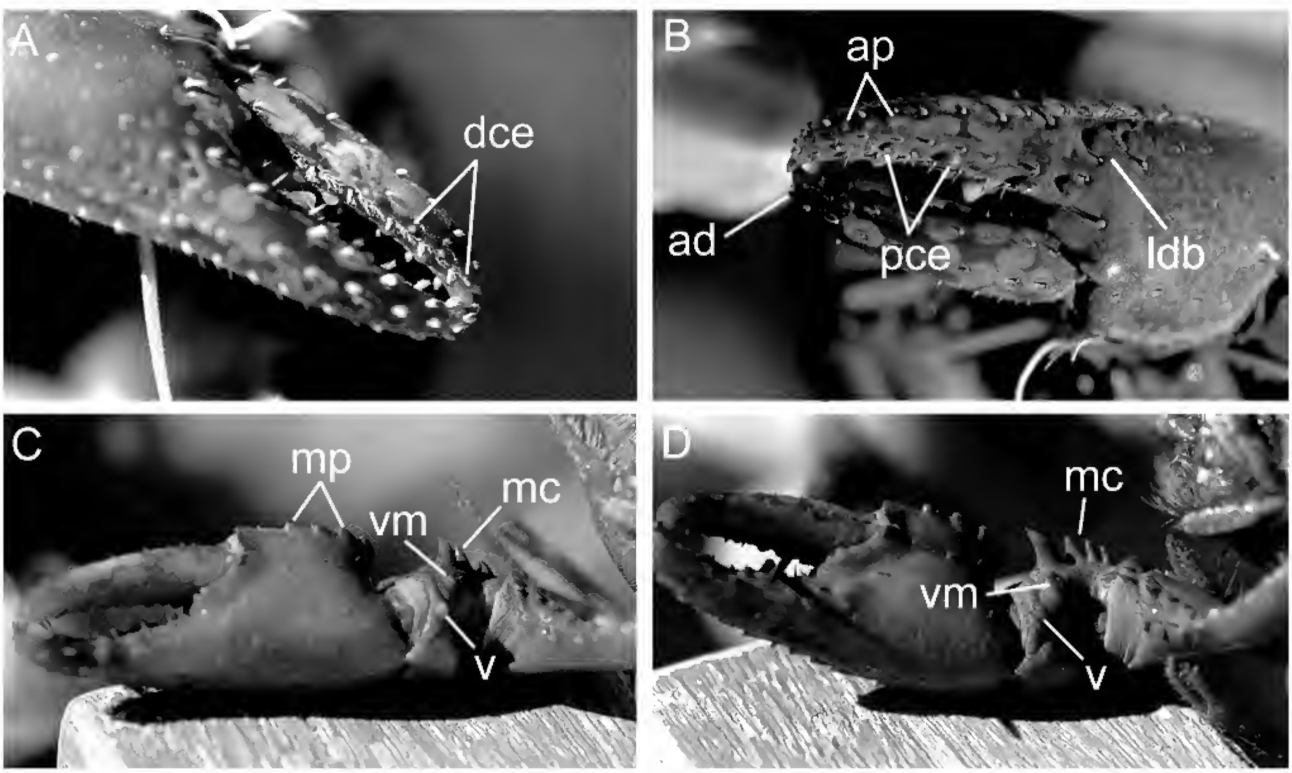

Figure 4. Distinguishing features of the chela of *Euastacus mirangudjin* n.sp. Dorsal view (A, B) and ventral view (C, D) of chela of holotype (A, C) and paratype (B, D). ad, apical mesial dactylar spine (1 spine); ap, dorsal apical propodal spine row (3–4 spines); dce, spine row above dactylar cutting edge (3–4 spines); ldb, bumps and protuberances lateral to dactylar base; mc, mesial carpal spines (usually 3, paratype with 4); mp, mesial propodal spines (5); pce, spine row above propodal cutting edge (4–7 spines, extending to base of chela gape); v, ventral carpal spine (large); vm, ventromesal carpal spine (1 spine, smaller than or as large as ventral carpal spine). Photographs by Max Egan.

Table 1. Morphological traits distinguishing *Euastacus mirangudjin* n.sp. from *E. reductus, E. setosus, E. urospinosus, E. maidae* and *E. jagara*. (Character traits for *E. reductus* taken from Morgan (1997). Character traits for *E. setosus, E. urospinosus, E. maidae* and *E. jagara* taken from Morgan [1988])

feature	*E. mirangudjin*	*E. reductus*	*E. setosus*	*E. maidae*	*E. jagara*	*E. urospinosus*
suborbital spine	small to medium	usually small or very small, medium on some specimens	large or very large	small	very small or small	small to medium
thoracic spines	absent	absent	absent	absent	absent	1–3, small, blunt or moderately sharp
Li spines on 2nd somite	1–5 spines, moderately sharp	1–8 (usually 2–5), sharp or moderately pointed	2–3 spines, blunt or very blunt	4–6 spines, moderately pointed to blunt	2–3 very blunt spines on holotype, (largest specimen) absent on others	2–3 spines, moderately pointed to blunt, absent on animals <20 mm OCL
dorsal apical propodal spines	3–4 spines	usually absent, some specimens with 1 or 2 spines	usually absent (rarely 1)	1–2 spines	absent	absent
spines above propodal cutting edge	4–7 spines	usually 1–3 spines, 4 on some regenerate chela	usually 1 apical spine	absent	absent	absent
mesal propodal spines	5 spines	4–7 (usually 5 or 6)	usually 4 spines, sometimes 3 or 5 (esp. on regenerate chelae)	3–4 spines	6–7 spines, 4–5 on animals <20 mm OCL	usually 5 (rarely 6)
apical dactylar spines	1 (mesal) spine	usually 1, sometimes 2 spines	2 (mesal) spines	1–2 (mesal) spines	1 (mesal) spine	usually 1 (mesal) spine
spines above dactylar cutting edge	3–4 spines	usually 1–3 spines	usually 1 apical spine	1 spine	1 apical spine on largest specimen, absent on animals <30 mm OCL	1 apical spine, absent on animals <20 mm OCL
mesal carpal spines	usually 3 spines, one specimen with	4 spines (3 on some regenerate chela)	usually 4–5 spines	4 spines	3–6 spines	4 spines
ventral spine size	4 large	small or medium	small or medium	very small or tiny	small to medium	medium/large to small
ventromesial spines	one spine	3–4 spines	3–7 spines	2–4 spines	"largest" and "other ventromesial spines" mentioned (more than one spine)	usually 3–4 spines
dorsal carpal spines	absent	absent	usually present	absent	absent (low bumps on largest specimen)	1–2, small

Colouration—body dorsally red-brown to green-brown; ventrally orange, with orange colouration extending up onto lateral branchiostegites on larger animals; abdominal pleura blue, brown on one specimen; abdominal spines yellow; cervical and cephalic spines yellow, orange, or orange with yellow tips; carpus dark brown dorsally, ventrally orange tinged mesially with blue-brown; dorsal surface of propodus mottled green-brown; propodus ventrally orange, mesially brown. Mesial propodal spines blue; lateral propodal spine ridge blue to green-brown, with yellow or light brown spines; fingers dark brown with paler or yellow tips. *Sexes*—males possess a cuticle partition; a berried female was caught with an OCL of 37 mm; the eggs carried were bright red in colour; the holotype, a 30 mm OCL female, has proportionally similar abdomen width (relative to OCL) to the slightly larger male paratype, suggesting an immature sexual state (see Honan & Mitchell, 1995). Further biological research is required to better ascertain size at onset of sexual maturity. The species would appear to have a winter/spring breeding season, which has also been recorded for other *Euastacus* species (Clark, 1937; Turvey & Merrick, 1997; Borsboom, 1998; Honan, 1998).

Biology. The species is known only from one site, in Iron Pot Creek. The specimens were caught during the dry season (in September), which appears to coincide with the breeding season.

Etymology. From the Bundjalung Aboriginal language "miran", meaning belly or chest (Holmer, 1971; Smythe, 1978) and *gujihn* [*gudji:n, gudi:n*], meaning ochre, red or orange (Crowley, 1978; Smythe, 1978; Sharpe, 1985). The species could be colloquially referred to as the "ochre-bellied crayfish" or "orange-bellied crayfish". The specific epithet is used as a noun in apposition. The species is bright orange ventrally like *E. gumar*, although the orange colouration is more striking, remaining vivid as it extends ventrally over the walking legs, and extending well up onto the lateral branchiostegites of the carapace on larger specimens. The larger specimens in particular appear to glow orange from underneath.

Remarks. *Euastacus mirangudjin* is morphologically similar to *E. reductus*, from further south in the Port Macquarie region, and the species forming the *setosus* complex in southeastern Queensland (*E. jagara* Morgan 1988, *E. maidae* Riek 1956, *E. setosus* Riek 1956 and *E. urospinosus* Riek 1956). Table 1 outlines morphological traits which can be used to distinguish *E. mirangudjin* from these species. The distinguishing spination of the chelae of *E. mirangudjin* is shown in Figure 4.

Discussion

The species described here increases the recognised number of species in the genus *Euastacus* to 43, and the number of *Euastacus* occurring in New South Wales to 25. The species is easily distinguished from other northeastern New South Wales species, which are generally larger and/or spinier. The species more closely resembles species forming the *setosus* complex in southeastern Queensland (*E. jagara, E. maidae, E. setosus* and *E. urospinosus*). The latter three of these species were designated as belonging to a separate genus, *Euastacoides*, by Riek (1956). Morgan (1988) synonymised *Euastacoides* with *Euastacus*, arguing that some species of *Euastacus* display characters Riek had considered unique to *Euastacoides*. Two of these traits are also exhibited by the present species:

- The ventrolateral propodal spine row of the species is either absent or poorly developed into a single, blunt spine at the midlength of the propodus.
- The ventromesial carpal spine is as large as the ventral spine on some individuals. However, the ventromesial/ventral spine size relationship is variable, with the ventromesial spine being smaller than, as large as, or slightly larger than, the ventral spine. Unlike the species in the *setosus* complex, the ventral spine is large.

However, the species bears abdominal spines, and can thus be considered separate from the *setosus* complex. Instead, like *E. reductus* (see Morgan, 1988), the species represents an intermediate condition between the *setosus* complex and most species of *Euastacus*.

The type locality is a highland rainforest stream. The species was caught by actively sampling the rocky edges of the stream. This entailed turning over rocks and capturing the crayfish by hand. The crayfish were caught behind these rocks, above the stream water level. Numerous burrows were noted in the stream channel, though no crayfish could be enticed from these burrows with baits. These burrows may belong to the presently described species, although they could also be burrows of *Euastacus sulcatus* or *E. valentulus*, which both inhabit the area (Leckie, 1999). The broader distribution of *E. mirangudjin* is unknown, and this should be considered as a significant research gap. Other small species of *Euastacus* have been found to be restricted to highland areas (Morgan, 1997). For example, the present species was discovered while conducting research on *E. gumar*, which was found to be restricted to five isolated, highland populations, with a total estimated extent of occurrence of <30 km^2 (Coughran, 2000). These findings highlight the urgency of undertaking further research on poorly known species of *Euastacus*, such as the presently described species.

Only two specimens were retained from the type locality as museum voucher specimens. The other three specimens were released because it was apparent that this new species is potentially rare and most likely has a very restricted distribution. Although the present study, based on the western side of the Richmond Range, provides little scope for assessing the distribution of the species, it is significant that Leckie (1999) did not record the species at any of the three sites he sampled directly downstream of the type locality. Rather, Leckie (1999) recorded the relatively common and widespread species *E. valentulus* and *E. sulcatus* in his study. At this stage, this new species *E. mirangudjin* appears to satisfy two criteria for listing as an endangered species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. These criteria are:

1 Very restricted geographic distribution.

2 Extremely low estimated total number of mature individuals.

Further research is required to better determine the conservation status of this species.

ACKNOWLEDGMENTS. The study was undertaken at Southern Cross University, Lismore, New South Wales, under the supervision of Dr Don Gartside. Dr Gary Morgan examined the type specimens, and provided advice on the probable systematic position of the species. I thank Dr Gartside, Dr David Pollard and two anonymous reviewers for their constructive comments on the manuscript, Mr Max Egan for the photographs of the species and Mr Benjamin Black for assistance with the field work.

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Manuscript received 11 April 2001, revised 2 August 2001 and accepted 4 October 2001.

Associate Editor: Shane T. Ahyong.

Records of the Australian Museum (2002) Vol. 54: 31–40. ISSN 0067-1975

Review of *Pseudopleonexes* Conlan, 1982, With a New Species from Australia (Crustacea: Amphipoda: Ampithoidae)

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ABSTRACT. *Pseudopleonexes sheardi* n.sp. is reported from South Australia. This is the second named species in the genus known previously only from New Zealand. Conlan's (1982) original diagnosis of the genus (type species *Pleonexes lessoniae* Hurley, 1954) and the diagnosis in Barnard & Karaman (1991) differ in several respects. Thirty-six characters from those diagnoses and from *Pseudopleonexes sheardi* are compared in a table, and a number of those characters are discussed. *Pseudopleonexes sheardi* differs from Conlan's diagnosis in the palm of gnathopod 1 being slightly oblique rather than transverse, and in the reduced palp of maxilla 1 having a single article rather than 2. In view of several synapomorphies identified, those differences do not warrant separate generic recognition of *P. sheardi*. A new diagnosis of *Pseudopleonexes* is given. Specimens from New Zealand referred to *P. lessoniae* by Barnard (1972, as *Ampithoe (Pleonexes) lessoniae*) are discussed. The specimens probably represent two separate species, neither belonging to *P. lessoniae*. Further material is required to confirm or reject their inclusion in *Pseudopleonexes*.

JUST, JEAN, 2002. Review of *Pseudopleonexes* Conlan, 1982, with a new species from Australia (Crustacea: Amphipoda: Ampithoidae). *Records of the Australian Museum* 54(1): 31–40.

Ampithoid amphipods are common in marine shallow water algal and sea grass beds in all but the coldest parts of the world oceans. Most are relatively large, more than 10 mm, and belong in widely distributed genera. Many build loose abodes of silk and detritus among blades, while others are leaf curlers; a few build transportable abodes of leaf cuttings, or bore into algal stems. Australian ampithoids are poorly known, and until recently were difficult to identify. Poore & Lowry (1997) clarified some long standing problems and described five new species from New South Wales. Just (2000) described two new species from southern Australia.

Hurley (1954) described a new species of Ampithoidae, *Pleonexes lessoniae*, from New Zealand. Three specimens from New Zealand were referred to *Ampithoe (Pleonexes) lessoniae* (Hurley, 1954) by Barnard (1972). Conlan (1982) created the new genus, *Pseudopleonexes*, for *Pleonexes lessoniae*. Barnard & Karaman (1991) presented an expanded diagnosis of *Pseudopleonexes*.

The discovery, in southern Australia, of an undescribed species similar to *P. lessoniae*, but differing in some characters used by Conlan (1982) in her diagnosis of the genus, prompted this review of the genus.

The length of animals was measured from the middorsal front margin of the cephalon along the curvature of the dorsum to the apex of the telson. The material is in the Australian Museum, Sydney. Superscript numbers throughout this work key to bold character numbers in Table 1.

Table 1. Original diagnosis of *Pseudopleonexes* Conlan, 1982 compared with diagnosis in Barnard & Karaman (1991) and *P. sheardi* n.sp. from Australia. Numbers in bold key to superscript numbers in the text where characters are discussed. •, as diagnosed. —, no information given. Text in italics = characters considered diagnostic of *Pseudopleonexes* following discussion in the text.

	Conlan (1982)	**Barnard & Karaman (1991)**	***P. sheardi* n.sp.**
1	*head lobes [ocular lobes] produced, antennal sinus present*	ocular lobes short, antennal sinus weak	•
2	—	eyes absent	eyes present
3	—	*antenna 1 peduncle article 3 shorter than 1*	•
4	—	antenna 2 peduncle article 3 short	•
5	*antenna 1, accessory flagellum absent*	•	•
6	—	epistome produced anteriorly	epistome rounded anteriorly
7	—	*upper lip subrounded, entire*	•
8	*mandibular palp moderately well developed 3-articulate,* articles 2–3 marginally setose	weak, very slender, article 3 rectolinear (?), shorter than 2 (?)	slender, 3-articulate, article 2–3 subequal, 3 with projecting apex, 2–3 with apical setae only
9	—	mandible with reduced molar, somewhat conical, apically blunt	*mandibular molar conical, triturative*
10	*lower lip, outer lobes barely notched*	•	•
11	—	*mandibular lobes short, thick, pointed*	•
12	*maxilla 1 palp reduced, apically setose, lacking spines*	weak, 2-articulate	1-articulate, tiny, 2 apical simple setae
13	—	maxilla 1 outer plate with 7 spines	*maxilla 1 outer plate with 10 robust setae*
14	—	*maxilla 1 inner plate linguiform,* with 1 medial seta	• (*1–2 setae*)
15	—	*maxilla 2 inner plate with medial marginal setae only*	•
16	—	maxilliped inner plate with distal spines; outer plate exceeds palp article 2	inner plate without spines; *outer plate not exceeding palp article 2*
17	—	*gnathopod 2* greatly *larger than 1*	•
18	gnathopod 1 palm transverse	• (almost simple in male)	well developed, nearly straight, slightly oblique
19	—	gnathopod 1 article 5 as long as 6	*gnathopod 1 article 6 longer than 5*
20	—	*gnathopod 2 weakly subchelate, article 2 dilated, 5–6 strongly setose*	• (5–6 medially setose in male only)
21	*coxal plate 1 not forward produced*	•	•
22	—	coxal plates of ordinary length, plates 1–4 progressively longer	*coxal plates 1–5 of equal length, none longer that wide*
23	*coxal plates 1–5 with 1 longer seta posteroventrally*	•	•
24	—	epimeron 3 not bisinuate	•
25	*pereopods 3–4 article 2 strongly inflated*	•	•
26	—	*pereopods 5–7 dissimilar, prehensile, pereopod 5 short with article 2 lobed, pereopods 6–7 article 2 not lobed*	•
27	pereopods 5–7 article 6 distally expanded,	*pereopods 5–7 prehensile, 5 much shorter than and different from 6–7,* spines in anterodistal part only	• (margins parallel)
28	—	*uropods 1–2 rami much shorter than peduncle*	•
29	uropod 1 peduncle distal [ventroapical] process absent	uropods 1–2 peduncle process absent	•
30	*uropod 3 outer ramus uncini and serration strongly developed*	•	•
31	—	*uropod 3 inner ramus shorter than outer ramus, pad-like, apically setose*	•
32	*telson with 2 upcurved, fleshy hooks*	•	•
33	—	telson pentagonal	*telson triangular*

Additional characters from *P. sheardi* n.sp., not in the above diagnoses. See discussion in the text.

(*a*) *epistome and upper lip directed backwards at more that 45 degrees.*
(*b*) *uropod 1 reaching to middle of peduncle of uropod 2 only* (also evident in *P. lessoniae*).
(*c*) *peduncle uropod 2 in male with broad, rounded laterodistal projection* (also evident in *P. lessoniae*).

Taxonomy

To assess the generic placement of the new species from Australia described below, Conlan's (1982) and Barnard & Karaman's (1991) diagnoses are compared (Table 1) together with characters of the new Australian species. Barnard & Karaman addressed the 14 characters listed by Conlan and added 30 characters in their diagnosis. Some characters are omitted from Table 1 as they are generalised ampithoid characters, while some others have been consolidated into one entry. Poore & Lowry (1997), without new information, gave a brief diagnosis of *Pseudopleonexes*, which largely follows Conlan (1982), although their characterisation of the lower lip provides for notched as well as entire outer lobes (weakly notched in the type species); their diagnosis of male gnathopod 1 and pereopods 5–7 combines traits listed by Conlan and by Barnard & Karaman (1991) and in the case of gnathopod 1 apparently includes Barnard's (1972) New Zealand specimens referred to *Ampithoe (Pleonexes) lessoniae*.

Discussion of characters used in diagnoses. In the following discussion, superscript numbers refer to characters in Table 1. The three key papers pertinent to the discussion, Hurley (1954), Conlan (1982) and Barnard & Karaman (1991), are referred to by name of author(s) only. Hurley stated that his new species *Pleonexes lessoniae* lacks eyes. Conlan, [2] studying unspecified material of *Pseudopleonexes*, did not mention lack of eyes in her diagnosis. Lack of eyes was included by Barnard & Karaman in their diagnosis. Specimens referred by Barnard (1972) to *Ampithoe (Pleonexes) lessoniae*, have large well-developed eyes. All other 105+ species of ampithoids and related Biancolinidae have eyes (Thurston & Bett 1993, appendix 1). In the new Australian species, eyes are well developed, but scattering and retraction of ommatidia are evident in some specimens (Fig. 1) presumably as a result of late fixation or tissue contractions due to the preservatives used. This is a common phenomenon in a range of amphipods, which may prevent verifying the presence or absence of eyes from an external examination of preserved material. Lack of eyes in a free-living shallow water species in a family of predominantly shallow-water occurrence, all with eyes, would be unusual if not unlikely. On this basis, I assume that Hurley's assertion was erroneous.

The only corroboration of Barnard & Karaman's statement about an anteriorly produced epistome [6] is the indication of a low, distal bulge in Hurley's fig. 1.6. A similar low bulge is present in the new Australian species (not illustrated). The weak rounding in *Pseudopleonexes* may not merit recognition as a diagnostic character.

Conlan [8] recorded a moderately well developed, 3-articulate mandibular palp (distal part of palp broken in Hurley's original material). Barnard & Karaman suggested that article 3 is shorter than 2 (perhaps as a reference to the condition in the miniature palp shown by Barnard (1972: fig. 13) in his *Ampithoe (Pleonexes) lessoniae* specimens). The new Australian species matches Conlan's diagnosis.

Barnard & Karaman [9] characterised the mandibular molar as reduced, somewhat conical and apically blunt. In the Australian species, the molar is moderately conical with a strong irregularly transverse grinding surface as also shown by Hurley (fig. 1.9) for *P. lessoniae*. Hurley's fig. 1.8 shows the opposing mandible to have a more reduced, apically transverse molar. To judge from the angle of illustration and from the differently sized laciniae mobiles, Hurley may have mistaken the left mandible for the right in the legend to his fig. 1. The mandibles in the Australian species are generally similar to *P. lessoniae*.

Hurley's [12] fig. 1.4 shows maxilla 1 with a reduced palp of two articles not reaching the apex of the inner plate and with apical setae only. In the new Australian species the palp of maxilla 1 is reduced to 1 small article with a few terminal setae. This character may be seen as a difference of generic significance or as a progressive reduction within the same genus. The character must be assessed in the light of overall similarity between *P. lessoniae* and the new Australian species (see conclusion, below).

Hurley [13] explicitly wrote about maxilla 1 "Outer plate... 10 strong, toothed spines". The new Australian species has 10 spines (= robust setae). I conclude that Barnard & Karaman's statement (7 spines) is incorrect. (A similar error is found in Barnard & Karaman's diagnosis of *Pseudo-amphithoides* "with 7 spines", although Just [1977, as *Amphyllodomus*] stated "with 9 spines").

Barnard & Karaman [16] diagnosed *Pseudopleonexes* as having "distal spines" on the inner plate of the maxilliped. Hurley's fig. 1.3 shows a single, medioapical, slender robust seta of about half the length of surrounding plumose setae. In the new Australian species there are plumose setae only. This difference is not considered of importance in assessing the generic placement of the Australian specimens.

Furthermore, neither Hurley's fig. 1.3 nor the Australian material corroborate Barnard & Karaman's statement about the outer plate of the maxilliped. In both cases, the outer plate reaches to about the apex of palp article 2.

Conlan's diagnosis of the palm of gnathopod 1 [18] differs from that of Barnard & Karaman. Conlan's diagnosis stresses the transverse nature of the palm; Barnard & Karaman's diagnosis emphasises its reduced size in males. *Pseudopleonexes lessoniae* has a well-developed transverse palm about half the length of the cutting edge of the dactylus, posteriorly defined by one robust seta (Hurley, 1954: fig. 2.1 and 2.2). Barnard & Karaman's interpretation presumably refers to the almost non-existing palm in specimens illustrated by Barnard (1972, fig. 14a,c, as *Ampithoe (Pleonexes) lessoniae*). In the new Australian species, the palm of gnathopod 1 is faintly oblique, slightly convex, between half and two thirds the length of the cutting edge of the dactylus and defined by one robust seta. In addition, Hurley's illustrations and the new Australian species have article 6 of gnathopod 1 [19] distinctly longer than 5 as opposed to Barnard & Karaman's statement.

The shape of the palm of gnathopod 1 is an important character in Conlan's delimitation of ampithoid genera. Hence the significance of the differences outlined are discussed below.

Barnard & Karaman [22] stated that coxal plates are of "ordinary length, progressively elongate from 1 to 4". The meaning of "ordinary" is not clear. Most large ampithoids (e.g., *Ampithoe, Amphithoides, Cymadusa, Paragrubia, Peramphithoe, Pleonexes, Plumithoe, Sunamphitoe*) have coxal plates 1–5 longer than wide and frequently increasing somewhat in length posteriorly, which would seem to be the "ordinary" condition referred to. *Exampithoe* (see Just, 2000) and *Pseudoamphithoides* (see Just, 1977), have short coxae 1–5, i.e. length equalling width or shorter. Hurley's

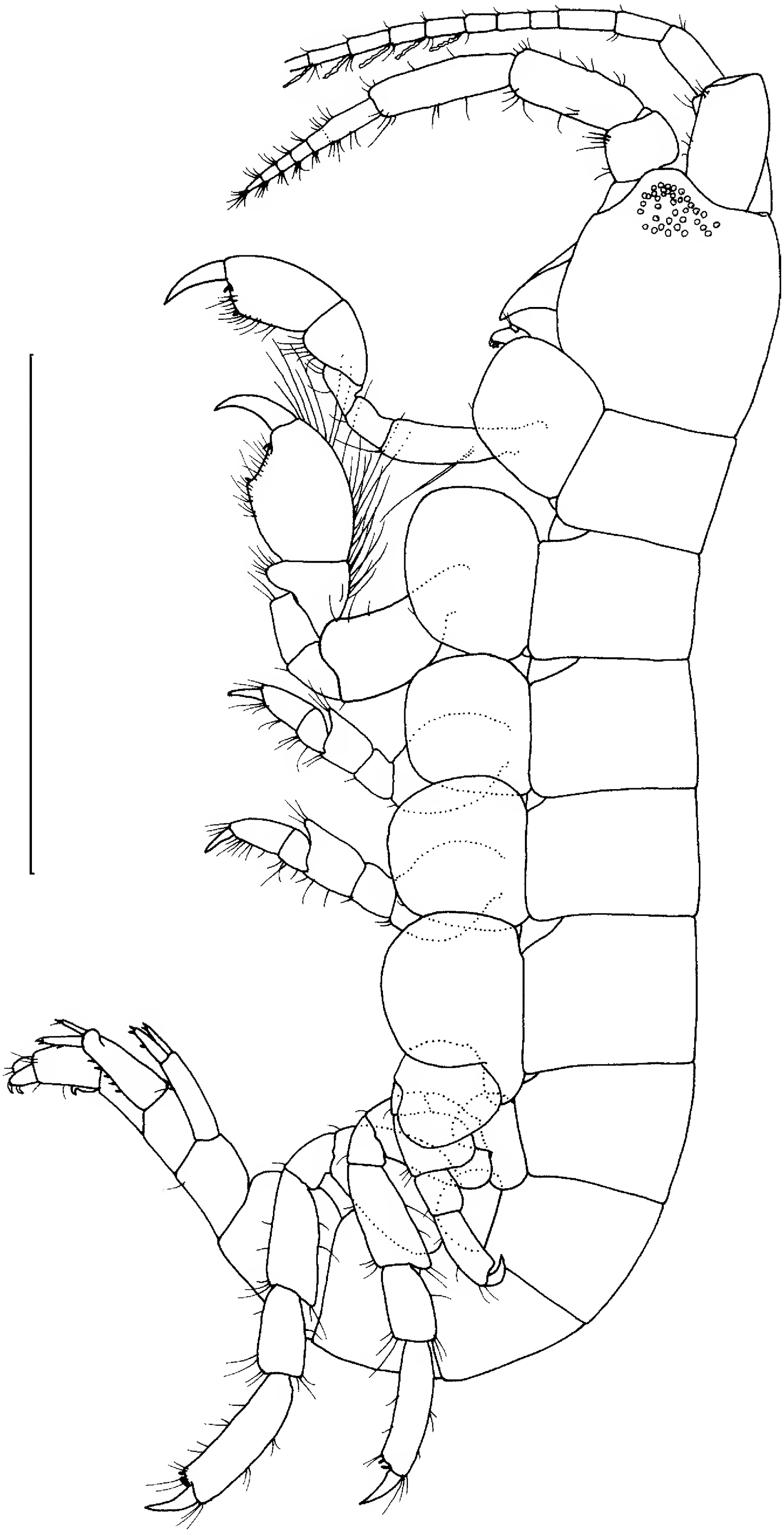

Figure 1. *Pseudopleonexes sheardi* n.sp., holotype, male, 3.5 mm. Scale 1 mm.

illustrations are inadequate for determining the exact length/width relations of individual plates or relative length of successive plates. They do not seem to differ significantly from the new Australian species in which the length of individual plates does not exceed their width, and successive plates are of similar length.

The degree of expansion, article 6 of pereopods 5–7 in *P. lessoniae* [26, 27] decreases from distinct in pereopod 5 to hardly noticeable in pereopod 7 (Hurley, 1954: fig. 2.8–2.10), with a single robust seta defining the prehensile palm in all three pereopods. The new Australian species does not have article 6 expanded in pereopods 5 or 6, but otherwise shares with *P. lessoniae* the short, prehensile palm defined by a single robust seta. Variation in the degree of distal expansion of article 6 in one or more of pereopods 5–7 occurs within most ampithoid genera. At the genus level, prehensility (a short palm with grasping seta(e) and a short, curved dactylus as opposed to simple, non grasping pereopods 5–7) is of greater significance than the degree of extension of the palm resulting in article 6 becoming more or less expanded distally. In this regard, the new Australian species is closely similar to *P. lessoniae*. The new Australian species is in agreement with Barnard & Karaman's statement regarding differences between pereopod 5 and pereopods 6 and 7.

Barnard & Karaman [33] described the telson as pentagonal. While perceptions of form may differ, I believe the telson in *P. lessoniae* is better described as triangular (cf. Hurley, 1954: fig. 1.20; this paper Fig. 4).

Additional characters. Three characters observed in the Australian material but not mentioned by Conlan or Barnard & Karaman have been added in Table 1 (a–c), as I believe all three are of diagnostic value in defining *Pseudopleonexes*.

(*a*) The mouthpart bundle is directed backwards at an unusual angle of more than 45 degrees which, to my knowledge, is unique in the Ampithoidae. Hurley did not mention or illustrate the configuration of the mouthpart bundle.

(*b*) Ampithoids generally have uropod 1 longer than, and reaching well beyond the peduncle of, uropod 2; in most genera uropod 1 reaches about as far back as the apex of the rami of uropod 2. In the new Australian species, uropods 1 and 2 are of equal length, and uropod 1 reaches to about the middle of the peduncle of uropod 2. Hurley did not illustrate the entire urosome, but he wrote of uropod 2 "As long as first; in situ reaching past 1st and 3rd." indicating a configuration relative to uropod 1 similar to the Australian species. Barnard (1972: 44 and fig. 13h) drew attention to the short uropod 1 in his *Ampithoe (Pleonexes) lessoniae*. Only in *Pseudoamphithoides* does the configuration of uropods 1 and 2 approach that described above (Just, 1977: fig. 1).

(*c*) Presence or absence of a mid-ventroapical projection (pointed or blunt) on the rami of uropods 1 (and 2) is of significance in distinguishing between ampithoid genera. Such projections are absent in *Pseudopleonexes* (see character 29, Table 1). Males of *P. lessoniae*, (Hurley, 1954: 625, fig. 1.16), and males of the Australian species (Fig. 4, herein) however, have a broad, rounded distolateral lobe on the peduncle of uropod 2. Whether the projection in *Pseudopleonexes* is homologous with the projection in other ampithoids or not, it is in a unique position and of a unique shape within the family.

Comments on Barnard's (1972) specimens. In the preceding sections I have drawn attention to specimens referred to by Barnard (1972) as *Ampithoe (Pleonexes) lessoniae*. It has not been possible to locate Barnard's material in any New Zealand collection. Barnard illustrated (in part) two males, one of which (JLB NZ-14; 4.8 mm; figs. 13j–p, 14f) shares important, presumably apomorphic, characters with *Pseudopleonexes lessoniae*, notably the distolateral lobe on uropod 2 and the backward pointing epistome-upper lip complex. This specimen has no palm and no defining robust setae on gnathopod 1. The other male (JLB NZ-10; 6.2 mm; figs. 13a–i, 14a–e) lacks the lobe on uropod 2, but shares the short uropod 1 and the broad, apically truncate, weakly notched lower lip with *Pseudopleonexes*. Gnathopod 1 of this specimen was not described or illustrated by Barnard (1972). The two specimens differ from each other in several other details outlined by Barnard (1972: 44) and variously from *P. lessoniae*. As suggested by Barnard (1972) they probably represent separate species. Neither are referrable to *P. lessoniae*.

One or both, notably the male reported as JLB NZ-14, may belong in *Pseudopleonexes*, which can only be confirmed or refuted by studying fresh material. I have found it reasonable, however, to include information from Barnard (1972) in structuring a new diagnosis for *Pseudopleonexes*, primarily in allowing for variation in the palm of gnathopod 2, and in incorporating the shape of the mouthpart bundle.

Conclusion. Because locating Hurley's original material of *Pleonexes lessoniae* in New Zealand collections was not successful, several potential synapomorphies between that species and the new Australian species cannot be evaluated, notably the elongated cephalon and the backward pointing mouthparts. One apparently unique apomorphic character, the distolateral rounded projection on the ramus of male uropod 2, is shared between the two species. In most respects, including details of antennae, mouthparts, pereopods and the entire urosome with uropods, the new Australian species is in good agreement with Hurley's description and illustrations of *P. lessoniae* and with Conlan's diagnosis.

As stated in the discussion of characters above, the new Australian species differs from *Pleonexes lessoniae* Hurley with regard to the palp of maxilla 1, and from Conlan's original diagnosis of *Pseudopleonexes* in respects to gnathopod 1 (Table 1, characters 12 and 18 respectively). I assume that Conlan diagnosed the new genus *Pseudopleonexes* as having the palp of maxilla 1 "reduced", rather than to specify what is obvious from Hurley's description and illustration, to accommodate other potential variations on the theme.

One of the characters used by Conlan in her diagnosis of the new genus *Pseudopleonexes* was the transverse palm of gnathopod 1 (forming a right angle with posterior margin of article 6). The new Australian species has a slightly oblique palm with a rounded posterior corner.

On the basis of current knowledge and in view of the overall similarity between *P. lessoniae* and the new Australian species, including several synapomorphies, I do not find it justifiable to separate them at the generic level on account of the observed variation in the reduction of the palp of maxilla 1 and in the shape of the palm of gnathopod 1.

Pseudopleonexes Conlan, 1982

Diagnosis. (Based on Conlan, 1982, with input from Barnard & Karaman, 1991 and the new species described below; cf. Table 1 and attendant discussion.) Ocular lobes produced, antennal sinus present. Antenna 1 peduncle article 3 shorter than 1; accessory flagellum absent. Epistome and upper lip directed backwards at approximately 45 degrees from the vertical. Upper lip subrounded, entire. Mandibular molar conical, triturative; palp moderately well developed, 3-articulate. Lower lip, outer lobes barely notched; mandibular lobes short, thick, pointed. Maxilla 1 palp reduced, with simple setae apically; outer plate with 10 robust setae; inner plate linguiform with a few short midmedial setae. Maxilla 2 inner plate with medial marginal setae only. Maxilliped outer plate reaching to apex of palp article 2. Gnathopod 2 larger than 1. Gnathopods 1 and 2, article 6 longer than 5. Gnathopod 1 palm variable. Gnathopod 2 weakly subchelate, article 2 dilated, articles 5–6 in male strongly setose medially. Coxal plate 1 not forward produced; plates 1–5 of equal length, none longer than wide, with 1 longer seta posteroventrally. Pereopods 3–4 article 2 strongly inflated. Pereopods 5–7 dissimilar, prehensile, 5 much shorter than 6–7; article 2 of pereopod 5 posteriorly lobed, of 6–7 without lobe. Uropod 1 reaching to approximately the middle of peduncle of uropod 2. Uropods 1–2 rami much shorter than peduncle. Uropod 2 peduncle in male with broad, rounded distolateral lobe. Uropod 3 outer ramus with 2 uncini, one of which weakly bifid, and transverse dorsal rows of acute cuticular scales; inner ramus shorter than outer ramus, pad-like, apically setose. Telson triangular, apically with 2 upcurved, fleshy hooks. Gills on gnathopod 2 and pereopods 3–6.

Pseudopleonexes sheardi n.sp.

Figs. 1–4

Material examined. HOLOTYPE: male, 3.5 mm, South Australia, W.R. Baker, 1910; from Sheard's collection; Australian Museum P35088. PARATYPES: nine specimens (including 2 adult males and 3 ovigerous females), South Australia, Yatala Harbour, Spencer Gulf, 32°45'S 137°55'E, 5 m, MV *Whyalla*, 8 March 1938, K. Sheard; Australian Museum P35090 and P59944 (♀ A, ovigerous, 3.1 mm); all specimens with more-or-less broken antennae and a number of pereopods lost.

Description (male). **Cephalon** longer than deep, lateral length, including ocular lobes, equalling first two pereonites combined, upper and lower margins nearly parallel; ocular lobes well developed, truncate; eyes present, round, (ommatidia scattered in holotype); antennal sinus shallow. Cephalon and body moderately compressed. **Coxal plates 1–4** rounded rectangular, width and depth subequal, plate 5 with anterior lobe similar to plates 1–4; plates 1–4 at most with one short posteroventral seta and a few more anterior tiny setules. **Pleonal sideplates** rounded, plate 3 faintly produced. Habitus of **antennae** close to *P. lessoniae* (Hurley, 1954: fig. 1); actual length of antenna 1 not known, but longer than 2. Peduncular article 4 of antenna 2 dorsally with two small knobs, each carrying a robust seta and a small simple seta; flagellum subequal to peduncular article 5 in length, with 8 articles (holotype) the proximal 2–3 of which are fused, middle 3–4 articles with distomedial rounded projection (Fig. 4). **Mouthparts**: Epistome-upper lip directed strongly backwards in lateral view (see also Barnard 1972: fig. 13j) forming an angle of approximately 45 degrees with the long axis of cephalon, this line of orientation being followed also by the mandibles. Mandibles with well-developed, slender, 3-articulate palp, article 2 with 1 apical seta, article 3 with 3 subapical setae in group, apex of article narrowly produced beyond setal group into marginally setulose, apically rounded point; spine row with broad-based, curved, unilaterally dentate robust setae. Lower lip with minutely bilobate outer lobes, outer sublobation rounded. Maxilla 1, outer plate broad, its plane somewhat rotated relative to inner plate (Hurley, 1954, described and figured the outer plate in *P. lessoniae* as distally tapering, which may be due to his angle of viewing a similarly rotated plate); palp 1-articulate, not much longer than broad at base, with 2 apical setae; inner plate with rounded apex and 2 (left) and 1 (right) medial setae. Maxilla 2 outer plate twice as broad as inner plate. Maxillipeds, outer plate rather slender, approximately twice as long as broad (length measured from apex to level of insertion of palp); inner plate without apical robust setae. **Gnathopod 1** with article 5 approximately ⅓ longer than broad and approximately ¾ the length of article 6; article 6 nearly twice as long as broad, palm convex, slightly oblique, defined distally by small, curved, blunt, striate robust seta and proximally by stout, normal robust seta at rounded wide angled corner. Gnathopod 2 article 2 broadly anterolobate; article 5 as long as broad, upper part of medial surface with field of long pectinate setae with strongly expanded base and even wider socket, setae orientated at right angle with surface (similar setae appear to be present in *P. lessoniae* Hurley, 1954: figs. 2, 4); article 6 nearly twice as long as 5, broadly ovoid, palm oblique, slightly convex (distal half) to concave (proximal half), defined by posterior right angle and robust seta as in gnathopod 1; upper ¼ of medial surface of article densely covered with wide-socketed setae as described for article 5. **Pereopods** 3 and 4 with broadly expanded article 2 (width to length = 4 to 5). Pereopod 5 with article 2 as broad as long, broadly produced posterodistally; article 4 with broadly rounded posterior lobe, article ¼ wider than long. Pereopods 6 and 7 with article 2 posteriorly expanded in proximal half, distally tapering. Palm of pereopods 5–7 similar, with short nearly straight palm defined by 1 stout, normal robust seta at rounded corner, with strong, curved, blunt, striate robust seta at base of dactylus; anterior margin of article 6 otherwise without robust setae. **Gills** short, oval, about twice as long as broad, present on pereopods 2–6. **Pleopods** with a single seta only on posterior surface of peduncle; with two coupling hooks. **Uropod 1** reaching ⅔–¾ along peduncle of uropod 2; peduncle with a single dorsal seta; outer ramus about half as long as peduncle, with 1 dorsal

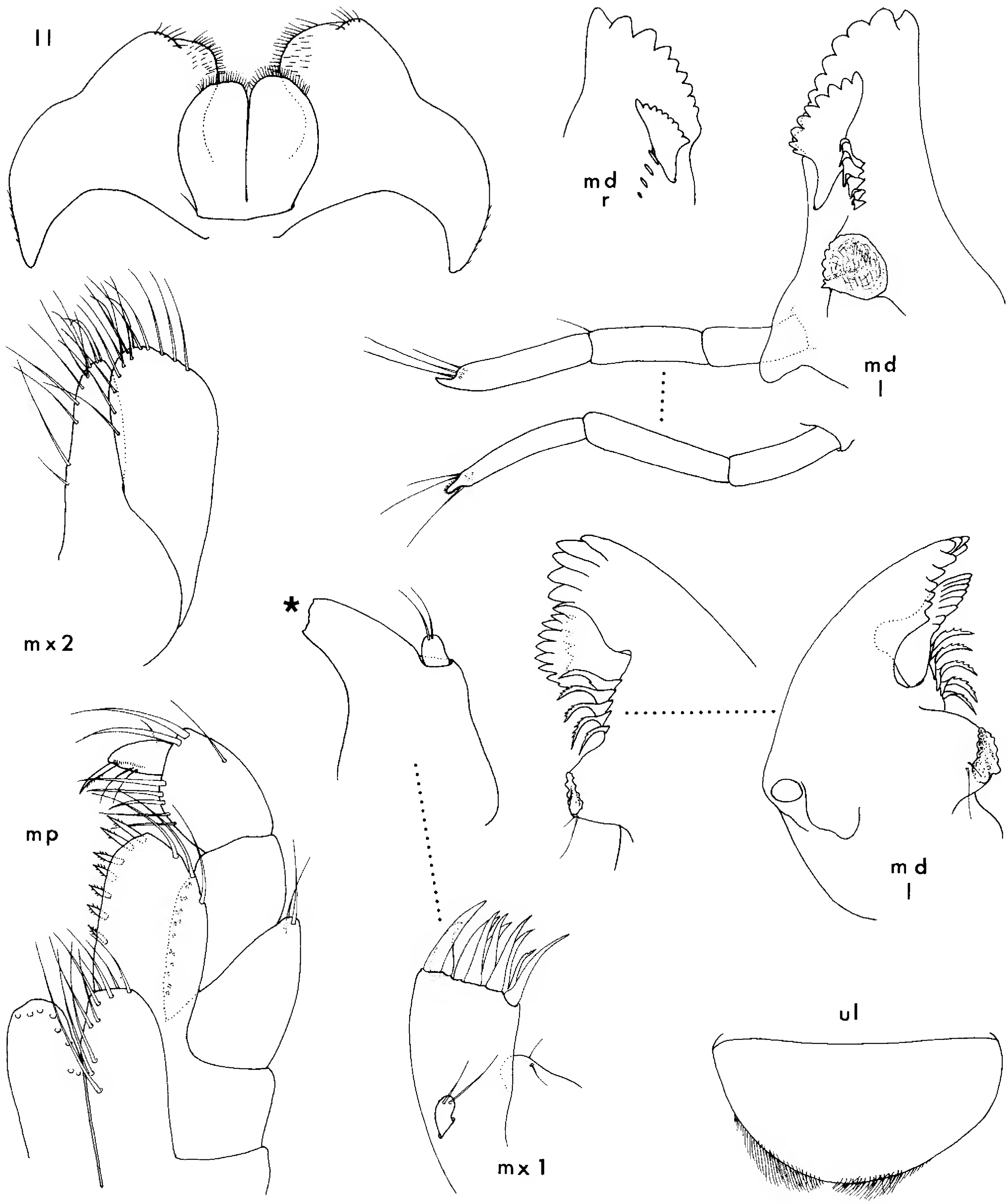

Figure 2. *Pseudopleonexes sheardi* n.sp., holotype. ll, lower lip; md, mandible; mp, maxilliped; mx, maxilla; l, left; r, right; ul, upper lip; *, maxilla 1 in different view, with outer plate apical robust setae omitted.

robust seta and 2 apical robust setae; inner ramus slender, cylindrical, slightly shorter than outer ramus, with 1 apical robust seta and 1 apical seta. Uropod 2 peduncle reaching beyond base of uropod 3, with 4 to 5 short, stout dorsal robust setae and bulbous distolateral lobe; rami as in uropod 1 except outer ramus with 3 apical robust setae of unequal size. Uropod 3, peduncle with a single middorsal seta, 1 to 2 dorsoapical setae and a few lateroapical setae; inner ramus with a few (1–3) apical setae. **Telson** in dorsal view triangular, slightly wider at base than long, lateral margins concave, apex with 2 strong, recurved hooks separated by right angled notch.

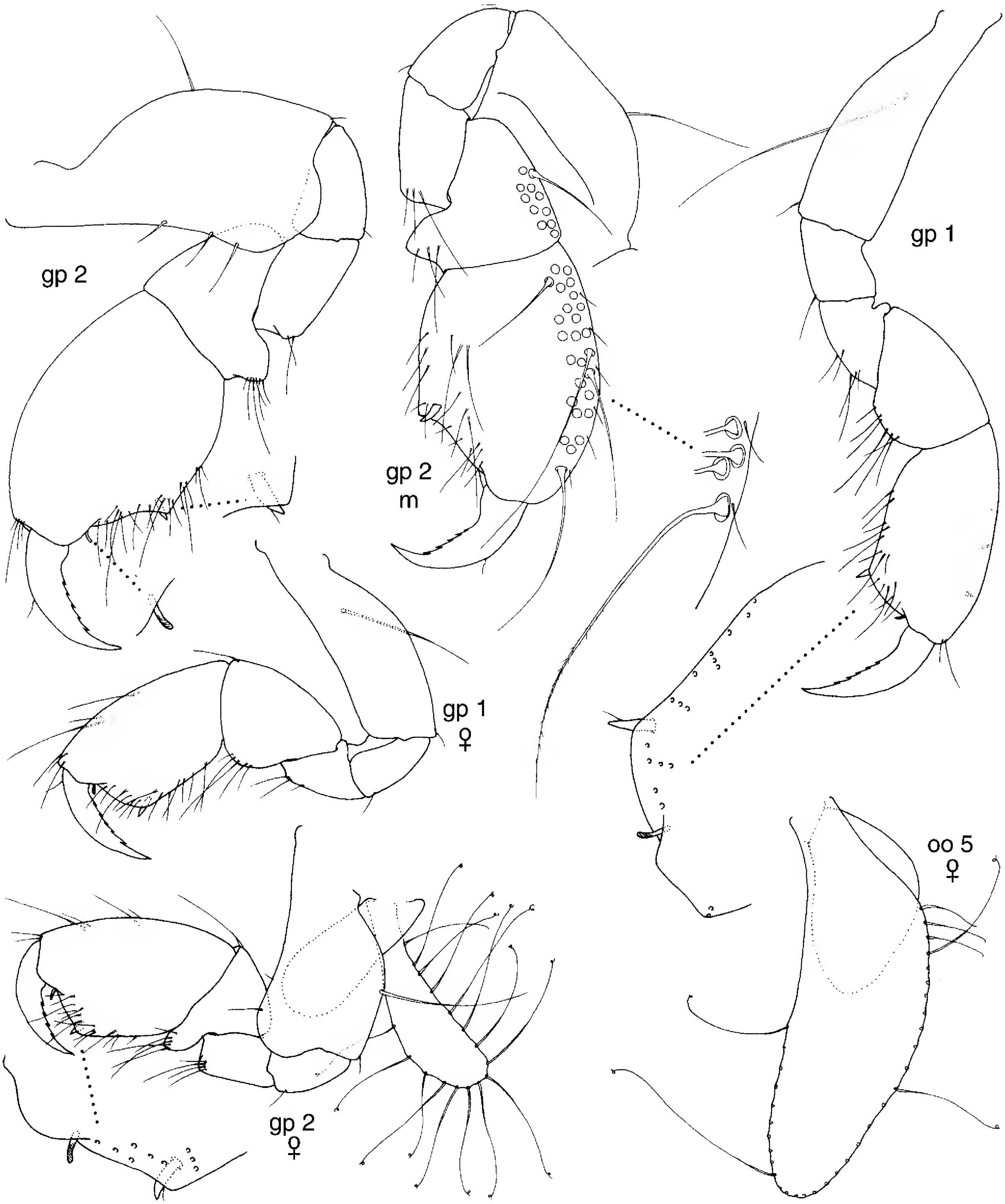

Figure 3. *Pseudopleonexes sheardi* n.sp., holotype, except where otherwise indicated. m, medial view; gp, gnathopod; oo 5, oostegite of pereopod 5; ♀, female paratype A.

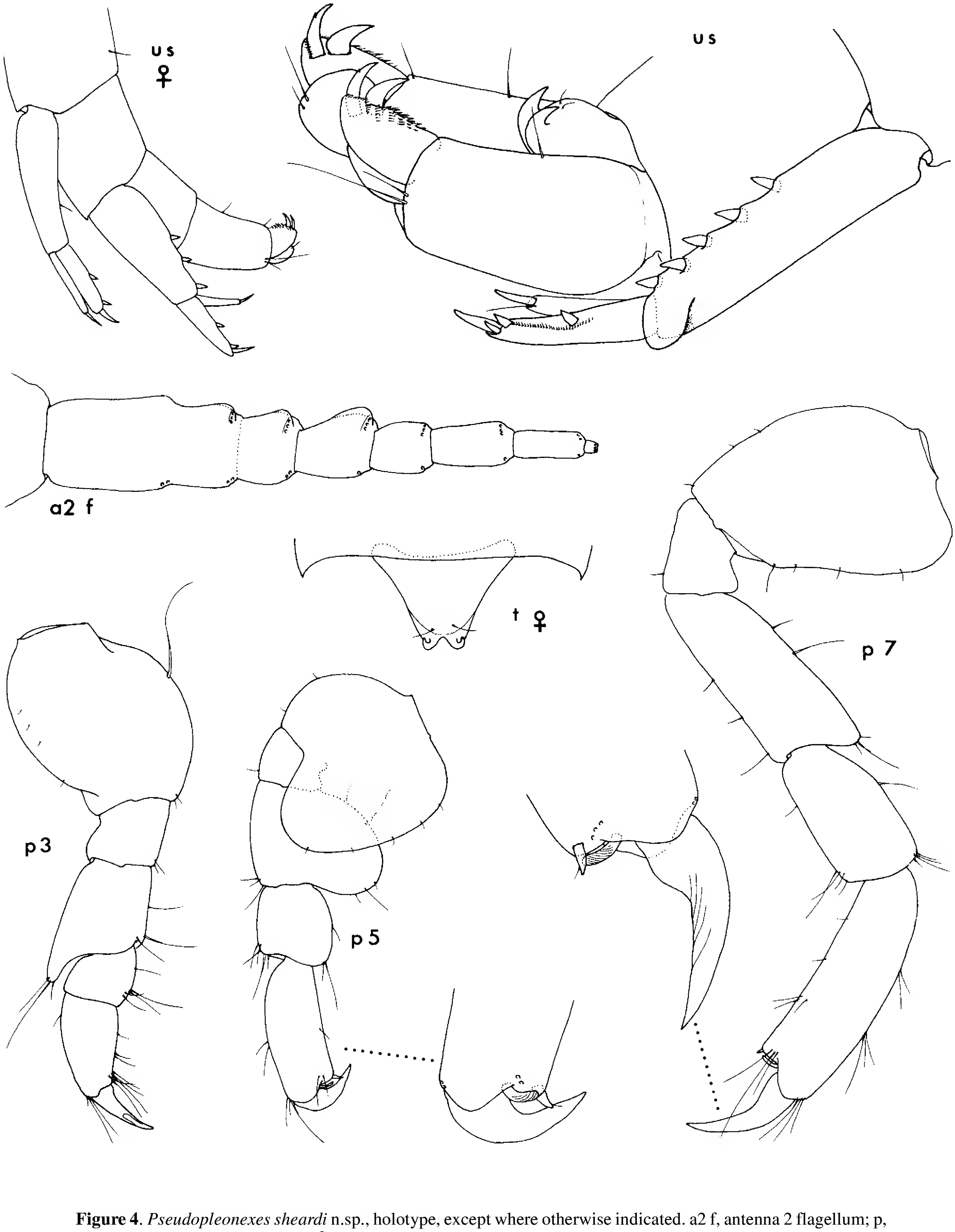

Figure 4. *Pseudopleonexes sheardi* n.sp., holotype, except where otherwise indicated. a2 f, antenna 2 flagellum; p, pereopod; t, telson; us, urosome; ♀, female paratype A.

Female. Differing from male in the following points: cephalon slightly less elongate. Article 6 of gnathopod 2 less strongly ovoid, with palm less oblique; articles 5 and 6 lacking specialised, wide-socketed setae. Peduncle of uropod 2 without lateroapical projection, with fewer dorsal robust setae.

Oostegites present on gnathopod 2 and pereopods 3–5, slender oval with long curly-tipped setae.

Size. Largest male: 3.8 mm; largest female: 3.3 mm; size range of ovigerous females: 3.1–3.3 mm.

Distribution. South Australia, Spencer Gulf, shallow water.

Etymology. The species is named after the Australian carcinologist K. Sheard, who collected the bulk of the specimens.

Remarks. *Pseudopleonexes sheardi* n.sp. differs from *P. lessoniae* in the following points: outer sublobation of lower lip rounded (pointed in *P. lessoniae*); gnathopods without tuft of long setae on posterior margin of article 2 (with such tuft); article 5 of gnathopod 1 one and a half times longer than deep (twice as long as deep); pereopods 3 and 4 article 2 without posteromarginal tuft of long setae (with such setae); pereopods 5–7 generally shorter and more robust, especially pereopod 5; article 4 of pereopods 5–7 without anterodistal projection (with projection); peduncle of uropod 1 without row of dorsolateral robust setae (with such setae); uropod 3, peduncle with a few scattered setae (3 to 4 groups of dorsal plumose setae), apex of inner ramus with a few simple setae (with about 9 plumose setae). *Pseudopleonexes sheardi* is a distinctly smaller species with largest known male <4 mm (male: 9 mm, female: 5.75 mm; Hurley, 1954).

ACKNOWLEDGMENTS. The present study is part of the results obtained during 10 months field and museum work in Australia (1984) undertaken with support from the Danish Natural Sciences Research Council (SNF 11-4180), the Carlsberg Foundation, Copenhagen, and the Australian Museum, Sydney. I thank the Australian Museum for providing access to this material. I thank colleagues in New Zealand museums and collections who helped in the search for Hurley's type material of *Pleonexes lessoniae* and Barnard's material of *Ampithoe (Pleonexes) lessoniae*, unfortunately to no avail.

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Manuscript received 2 June 2000, revised 22 September 2000 and accepted 13 October 2000.

Associate Editor: G.D.F. Wilson.

Records of the Australian Museum (2002) Vol. 54: 41–70. ISSN 0067-1975

New Genera of Phreatoicidea (Crustacea: Isopoda) from Western Australia

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ABSTRACT. Three new species belonging to new monotypic genera from Western Australia are added to the phreatoicidean isopod family Amphisopodidae: *Eremisopus beei* n.gen., n.sp. from the northwestern Kimberley region, *Peludo paraliotus* n.gen., n.sp. from Cape le Grand on the southern coast, and *Platypyga subpetrae* n.gen., n.sp. from Stirling Range. All species are illustrated using scanning electron micrographs. Both Ciliophora and ostracode Crustacea were found as epibionts on these species. All three isopod genera have highly restricted geographic distributions and could be threatened by anthropogenic degradation of their environments. Western Australia now has eight described genera of Amphisopodidae and Hypsimetopodidae, a generic diversity similar to Tasmania. Members of the Phreatoicidae, however, are absent in Western Australia. The distribution of Western Australian phreatoicideans suggests that they may have originally diversified in East Gondwana, while the Phreatoicidae show relationships to West Gondwana. A key to genera of Western Australia Phreatoicidea is included.

WILSON, GEORGE D.F., & STEPHEN J. KEABLE, 2002. New genera of Phreatoicidea (Crustacea: Isopoda) from Western Australia. *Records of the Australian Museum* 54(1): 41–70.

The description of two new isopod genera in the suborder Phreatoicidea (Wilson & Keable, 1999; Knott & Halse, 1999) and a new species of *Crenoicus* (Wilson & Ho, 1996) foreshadow the existence of considerable undescribed diversity in this suborder. The systematics, evolutionary history and biogeography of the Phreatoicideans have been treated elsewhere (Wilson & Johnson, 1999; Wilson & Keable, 2001). In this paper, we add three new genera from Western Australia (*Peludo, Eremisopus*, and *Platypyga*), that were introduced as undescribed taxa in previous papers. These new genera further extend the morphological diversity of the Phreatoicidea, which will allow the relationships of its component taxa to be assessed from any systematic level. Such data are relevant, given the basal phylogenetic position accorded to the suborder (Wägele, 1989; Brusca & Wilson, 1991), and their Palaeozoic fossil record (Wilson & Keable, 2001). Although not considered here, the proposed sister group relationship between Insecta and malacostracan crustaceans (K. Wilson *et al*., 2000), or even between insects and isopods (Brusca, 2000), may be assessed using data from our figures. If any detailed external morphological synapomorphies of malacostracans and insects exist, they may be illustrated in this paper.

As part of our ongoing program to revise the suborder, we also provide a key to the genera found in Western Australia. Epibionts, conservation and biogeography of the new phreatoicidean taxa are discussed to provide new knowledge of the Gondwanan fauna of Western Australia, in which phreatoicideans often are listed as a minor component (e.g., Hopper *et al*., 1996).

Methods

Specimens were either preserved in 95% ethanol, or were fixed in 4% formaldehyde in the field and later transferred to 80% ethanol for storage. Preparation for scanning electron microscopy (SEM) involved rehydrating specimens and dissected parts, cleaning using an ultrasound bath, and dehydrating the specimens through an alcohol series to absolute ethanol. Drying the specimens for SEM was accomplished using either a carbon dioxide critical point method, or by transferring the specimens to hexamethyl-disilizane and then slowly air drying in a covered glass petri dish. Dissected parts were mounted vertically on SEM stubs using double adhesive carbon spots, or attached to small wires and clamped in a small vice. Specimens were imaged either on a LEO or a Cambridge scanning electron microscope and digital images were saved for later processing. Digital image microphotographs were taken using a Leica MZ8 dissecting microscope with an attached Pixera PVC100C camera connected to a computer. For calibration, a one-mm grid was photographed at all scales used. All images were processed using Adobe PhotoShop (ver. 5). After deleting the background, the plates were assembled by pasting each image into a transparent layer over a black background. Contrast, brightness and greyscale tones of each image were adjusted to standardise their appearance. In a few instances, some images were rescaled to match other images (e.g., pereopods).

Descriptions and the key were generated using the taxonomic database system DELTA (Dallwitz, 1980; Dallwitz *et al.*, 1999; Wilson & Keable, 1999, 2001).

Implicit characters

Unless indicated otherwise, the following characters are implicit in the descriptions; i.e, these character states are present but are not included in the description. This device is used to shorten the species descriptions so that characters applicable to most but not all phreatoicidean species are not constantly repeated. Implicit characters may appear explicitly in species descriptions but only if the states differ from the norm (e.g., representing autapomorphies or restricted synapomorphies). Features found in all three species described in this paper (but not necessarily most phreatoicideans) are also included in the following list of character states.

Head tubercles absent. Frontal process above antennula absent. Mouth field angling ventrally, mandibular insertion axis in lateral view nearly level, line projected anteriorly along mandibular insertion passing below base of antenna. *Pereonites* 2–4 lacking lateral tergal plates. *Pleonites* in lateral view much deeper than pereonites, with large pleurae, basal region of pleopods not visible; pleonite 1 pleura distinctly shallower than pleurae of pleonites 2–5. Pleonite 5 lacking dorsal median ridge. *Pleotelson* median dorsal ridge absent; lateral dorsal ridges absent. Posterior margin elongate pappose setae absent. Dorsal uropodal ridge terminating at pleotelson margin above uropods. *Antennula* article 4 shorter than article 3. Terminal article shorter than penultimate article. Penultimate article width approximately subequal to ante-penultimate article width. *Labrum* dorsal margin approximately same width as clypeus. *Mandible* palp article 1 well developed, easily visible. Incisor processes broad, width greater than thickness. Left incisor process with 3 distal cusps and 1 on dorsal margin. Left lacinia mobilis with 3 cusps. Right incisor process with 4 cusps. Right lacinia mobilis large, well separated and distinct from remainder of spine row, with two dentate plates, smaller plate on anterior surface of larger plate. Spine rows on projecting ridge between incisor and molar, distal margin protruding in ventral view relative to proximal margin, basal insertions crossing dorsally and then abruptly angling posteriorly. Spine rows with bifurcate spines, basal insertions in line between incisor and molar processes. Left spine row with first spine not separated from remaining spines. Molar process stout, heavily keratinised, wider than long; triturating surface heavily ridged, fine simple setae forming posterior row. *Maxilliped* endite distal tip with multiple subdistal biserrate setae on ventral surface. Palp article 4 shape subcircular. *Pereopod I* dactylus dorsal margin dense group of elongate setae absent; ventral margin midlength spine-like projection absent. Propodus palm ridge with low conical setae absent. Basis ventrodistal margin with multiple elongate setae; anteroproximal surface without dense group of setae. *Pereopod IV* dactylus distal accessory claw-spines present. Propodus articular plate on posterior side of limb present. *Pereopod VII* basis dorsal ridge distal margin indented. *Pleopod* exopods II–V proximal article distolateral lobes shorter than distal article. Endopods unilobed. Protopods I–II lateral epipods absent, III–V lateral epipods lobe-like. Pleopod I exopod ventral surface flat. Pleopod II endopod appendix masculina curved, distal tip margins smooth; endopod distal margin rounded; exopod distal segment longer than wide. *Uropod* protopod distomedial row of closely spaced setae absent; dorsolateral margin setae robust and simple; ventral ridge without rows of long laterally projecting setae. Endopod subequal-longer than exopod; spine on dorsal margin absent. Exopod shorter than pleotelson.

Key to the Western Australia genera of the Phreatoicidea

1 Pleotelson lateral lobes absent 2

—— Pleotelson lateral lobes forming vertical plates (Fig. 2E) 4

2(1) Pleotelson posterior margin entire (Figs. 1C, 2G); pleonites in lateral view much deeper than pereonites, with large pleurae, basal region of pleopods not visible .... *Crenisopus* Wilson & Keable, 1999

—— Pleotelson posterior margin cleft, flattened (Figs. 15, 21A–C); pleonites in lateral view much deeper than pereonites, with large pleurae, basal region of pleopods not visible (Fig. 15A) .... *Platypyga* n.gen.

—— Pleotelson posterior margin broadly indented; pleonites in lateral view having depth equal to depth of pereonites, without pleurae, basal region of pleopods visible 3

3(2) Uropod protopod dorsomedial ridge produced, spur-like; pereopods II–III propodus articular plate absent; pereopod IV prehensile, sexually dimorphic .... *Hyperoedesipus* Nicholls & Milner, 1923

—— Uropod protopod dorsomedial ridge not produced; pereopods II–III propodus articular plate present; pereopod IV simple, not prehensile .... *Pilbarophreatoicus* Knott & Halse, 1999

4(1) Pleotelson posterior margin entire (Figs. 1C, 2G, 9) 5

—— Pleotelson posterior margin cleft .... *Amphisopus* Nicholls, 1926

5(4) Antennal notch deep, with posterior extension; all body and limb surfaces covered with dense cuticular hair (Fig. 8A,C–E); mandibular palp article 1 tiny (difficult to see among cuticular hairs on mandible) (Fig. 10A,C) .... *Peludo* n.gen.

—— Antennal notch shallow, without posterior extension (Fig. 2A); body surfaces and limbs lacking dense cuticular hair; mandibular palp article 1 large and distinct (Fig. 3D) .... *Eremisopus* n.gen.

—— Antennal notch absent; body surfaces and limbs lacking dense cuticular hair; mandibular palp article 1 large and distinct .... *Paramphisopus* Nicholls, 1943

Amphisopodidae Nicholls, 1943

Remarks. Apomorphies of the Amphisopodidae include an oblique compound terminal article of the antennula, plates on the dorsal margin of the posterior pereopodal bases (always on the seventh pereopod) and pleotelson lateral lobes formed into vertically-oriented plates. Our phylogenetic evidence suggests, albeit weakly, that all three new genera described in this paper are members of the Amphisopodidae. *Eremisopus* n.gen. and *Peludo* n.gen. are related to *Eophreatoicus* Nicholls, 1926, with Eremisopus and *Eophreatoicus* as sister taxa. *Platypyga* n.gen., on the other hand, is not clearly associated with any clade within the Amphisopodidae in our current analyses (unpublished data), and lacks basal apomorphies of this family. If our presumed homology of the posteriorly cleft pleotelson is correct (discussed below), *Platypyga* n.gen. could be a sister group to a clade containing *Amphisopus* Nicholls, 1943 and *Phreatomerus* Sheppard, 1927. *Platypyga* n.gen. has mandibular similarities with members of the Amphisopodidae (particularly the form of the spine row), although the presence of the right lacinia mobilis is plesiomorphic for the Phreatoicidea (Wilson & Keable, 1999, 2001). Plate-like lateral lobes oriented vertically on the pleotelson, a synapomorphy of amphisopodids, are absent in *Platypyga* n.gen. This absence could be secondary, owing to the substantial modification of the pleotelson in *Platypyga*. Most amphisopodid taxa, except for *Platypyga* n.gen., also have a dorsomedial plate on the uropodal protopods. This absence also may be related to the modified configuration of the pleotelson in *Platypyga*. We consider the inclusion of *Platypyga* n.gen. in the Amphisopodidae to be provisional, and requiring further evidence.

The creation of three additional monotypic genera in the Phreatoicidea might seem excessive; our research (unpublished data), however, has shown that phreatoicidean taxa tend to form morphological and geographic clusters of species. The described species that we have scored from two multispecies amphisopodid genera, *Amphisopus* (*A. lintoni, A. annectans*) and *Mesamphisopus* Nicholls, 1943 (*M. capensis, M. abbreviatus*) show close similarities among congeners, morphometric distances (as calculated using the DIST tool in DELTA (Dallwitz *et al.*, 1999) from the cladistic characters in our dataset) of 0.04–0.05, while between generic distances are 0.3–0.37. The new taxa show distances of 0.18–0.36 from *Amphisopus* and *Mesamphisopus*, and 0.3–0.32 from each other. By comparison, the greatest distance observed in our database (0.62—occurring between *Nichollsia kashiense* Chopra & Tiarari, 1950 and *Crenoicus harrisoni*) is indicative of the morphometric differences between two families (Hypsimetopodidae and Phreatoicidae, respectively). Undescribed new species in currently monotypic genera (*Pilbarophreatoicus*—1–2 new species; *Eophreatoicus*, the sistergroup of *Eremisopus* n.gen.—up to 14 new species; 1 new species each for *Synamphisopus* Nicholls, 1943 and *Phreatoicoides* Sayce, 1900 described in Wilson & Keable, in press) also show similar low morphometric distances between congeners. Therefore, we do not believe that genera have been defined too finely, resulting in too many monotypic taxa.

Overall, genera in the Phreatoicidea tend to differ in the armament of the pereon, pleotelson and uropods, while species variation may be much more subtle. In the following, each species is diagnosed only once at the generic level because they belong to monotypic genera. Without having identified additional species in each genus, we cannot provide a more inclusive species diagnosis at this time.

Eremisopus n.gen

Type Species. *Eremisopus beei* n.sp.

Etymology. "*Eremisopus*" is derived from the Greek (gender masculine) for "lonely isopod", because this taxon has been found only in a single isolated stream near PAGO Mission, north of Kalumburu in the NW Kimberley.

Diagnosis. Pleonite 5 with dorsal median ridge. Pleotelson with dorsal median ridge and posterolateral ridges confluent with posterior margin; median lobe broad, with concave dorsal surface; postanal ridge triangular in ventral view, with robust setae at posterior apex; lateral lobes forming large vertical plates; dorsal uropod ridge curving strongly and extending posteriorly from uropods on pleotelson margin. Antennal flagellum proximal articles with dense cuticular hairs in male (fewer in females). Pereopod I dactylus distinctly shorter than propodal palm, propodal palm of male with approximately 30 robust setae. Pereopod V–VII basis with dorsal ridge plates as wide as basis shaft. Pereopod VII ischium dorsal ridge forming flange less than shaft width. Pleopods I–III protopods only with coupling hooks; pleopod II with lobe-like lateral epipod, appendix masculina shorter than endopod length, setose along entire margin. Uropod protopod dorsomedial plate higher than depth of protopodal shaft, with row of robust setae; rami distal tips pointed.

Remarks. *Eremisopus* n.gen. shares several character states with *Eophreatoicus* species including a plate-like ridge on the ischium of the posterior pereopods, a uropodal ridge on the pleotelson that curves smoothly toward the posterior margin, and a first pereopod with numerous conical stout setae and a dactylus shorter than the palm. Some, but not all, *Eophreatoicus* species also have a dorsal midline ridge on the pleotelson, similar to *Eremisopus*. A large postanal ridge of the pleotelson with stout setae is also present in both taxa, although more strongly developed in *Eophreatoicus*. The two genera differ in the size of the dorsal plate on the ischium of pereopod VII, being smaller in *Eremisopus*, as well as the presence of pleotelson lateral ridges in *Eremisopus*.

Eremisopus beei n.sp.

Figs. 1–7

"New Genus 3": Wilson & Johnson, 1999: 265, fig. 1.
"New Genus X3": Wilson & Keable, 2001, table 1.

Type material. HOLOTYPE ♂, WAM C 25049, bl 29.7 mm (formalin preserved), water temperature 24°C, depth 20 cm, slow flowing, 20 May 1997, C. Bee, D. Wilson & B. Hanson, 17 May, 1997. PARATYPES: formalin fixed—AM P60527, 6 ♂♂ (including 2 with exuvia, male "B" dissected to examine gut), 2 ♀♀ (including female "A" 22.6 mm, with exuvia, dissected for description), 2 mancas (offspring of female "A")—all collected originally as for holotype then kept in aquaria for various lengths of time; AM P61456, ♂ "D" bl 32.1 mm (dissected for description and illustration including; mouthparts, pereopods and pleopods), collection details as for AM P60527; AM P60528, 47 ♂♂, 2 ♀♀ (in amplexus with males), collection details as for holotype except—14°10.55'S 126°41.39'E (GPS), 26.0°C, pH 6.0, under rocks with gravel in flowing water, W. Ponder & G. Wilson, 18 June 1999, sample number WA576; AM P60529, 37 ♀♀, 5 indeterminate specimens, collection details as for AM P60528; WAM C 25050, ♂ bl 26.4 mm, 2 ♀♀ bl 17.3 mm, collection details as for AM P60528; AM P60530, female "D" bl 20.9 mm (dissected for pleopod description and illustrations), collection details as for AM P60528; AM P61453, ♂ bl 29.2 mm (dissected for SEM of mandibles), collection details as for AM P60528; AM P61454, ♂ bl 31.3 mm (dissected for SEM), collection details as for AM P60528; AM P61455, ♀ bl 18.6 mm (dissected for SEM) collection details as for AM P60528; ethanol preserved—AM P60531, 28 ♂♂, 11 ♀♀, 3 indeterminate specimens, collection details as for AM P60528.

Type locality. "South Creek", stream crossing road between Honeymoon Bay and PAGO Mission ruins, near Kalumburu Township, 15 km northeast of Honeymoon Beach, Western Australia, 14°10.529'S 126°41.408'E (GPS), fine sand, under rocks.

Etymology. We are grateful to Mr Cameron Bee who brought this species to our attention, hence the species name "*beei*" in his honour.

Diagnosis. See generic diagnosis.

Description based on male. *Colouration* in 70% ethanol cream-yellow with dense covering of grey chromatophores, chromatophores less dense on pereopods and pleonites than on pereonites. Live colour similar, but whiter under dark chromatophores.

Head (Figs. 1A,B, 2A) length shorter than width in dorsal view; width 0.82 pereonite 1 width; lateral profile of dorsal surface smoothly curved; surface rough; setae absent. Eyes bulging dorsolaterally; maximum diameter 0.25–0.33 head depth; dorsal margin convex, ventral margin straight; orientation of longest axis between horizontal and vertical; ocelli distinguishable as individual units (etched on surface, pigment not clearly segmented), pigmentation dark. Cervical groove sigmoidal, extending nearly to dorsal margin of head. Mandibular groove smoothly indented. Mandibular notch present. Clypeal notch present. Antennal notch shallow, without posterior extension. *Pereon* (Fig. 1A) broad, width exceeding head width (1.23 times); dorsal surface with transverse ridges, with scattered roughness, and smooth (roughness tending to be on posterior and lateral surfaces); setae on dorsal surface scattered, fine. Pereonites 2–7 in dorsal view wider than long. Coxal articulation of pereonites 2–4 fused (but with partial lateral suture more strongly developed in female than male), 5–7 free. Sternal processes absent. Typhlosole minimal, ventral invagination forming inverted U-shape in cross section (weak invagination); hindgut caecae absent. *Pleonites* (Fig. 1A) in dorsal view 2–4 respective lengths more than half the length of pleonite 5, 1–4 relative lengths subequal, 1–4 width 0.87 composite length in dorsal view. Pleonite 5 with dorsal median ridge. *Pleotelson* (Figs. 1A,C, 2E–G) lateral length 0.15 body length, 0.73 depth; dorsal length 1.35 width; depth 1.3 pereonite 7 depth. Posterior margin entire, reflexed dorsally, without irregular denticulations; median lobe width 0.5 pleotelson width, produced, greatest length 0.35 pleotelson total length; lateral lobes narrower than median lobe, distinct from median lobe, not extending posteriorly to median lobe, medial length 0.35 pleotelson total length; median lobe with 4 robust sensillate setae (on margin, ventral postanal ridge with a row of 10); lateral lobes with 2 robust sensillate setae. Dorsal uropodal ridge without setae. Ventral margin anterior to uropods with robust setae, setae denticulate and smooth, 17 altogether (approximately), posterior seta larger than anterior adjacent setae. *Antennula*

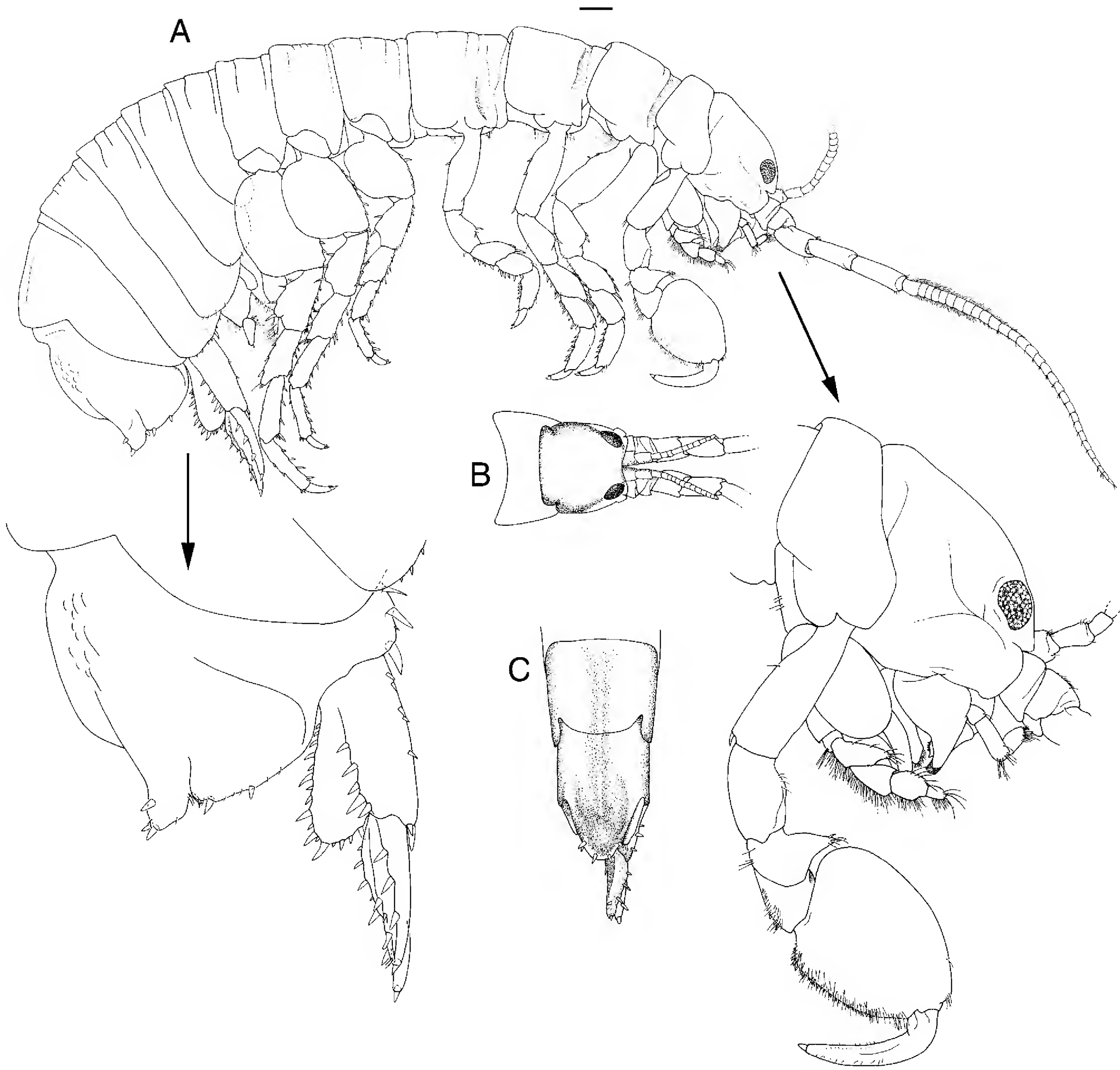

Figure 1. *Eremisopus beei* n.gen., n.sp. Holotype (WAM C 25049). A, lateral view, with enlargements of head and pleotelson; B,C, dorsal views of head and pleotelson. Scale bar 1 mm.

(Fig. 2A,B) length 0.1 body length, with 15 articles. Tiny aesthetascs on article 7 to terminal article. Terminal article distally oblique, with 2 or more groups of aesthetascs. Penultimate article length approximately subequal to length of other articles. Distal articles oval. *Antenna* (Figs. 1A, 2C,D) length 0.42 body length. Flagellum length 0.62 total antenna length, with 27 articles. Propodal article 1 absent. Article 5 longer than article 4, article 6 shorter than articles 4 and 5 combined. *Mouthfield* clypeus consisting of broad asymmetrical bar, rounded at mandibular fossae and with concave lateral margins, width 0.43 head width. Labrum weakly angular ventrally, appearing shield shaped to semicircular in anterior view. Paragnaths (Fig. 4A) with distolaterally rounded lobes, slightly produced disto-medially, having medial and lateral setal rows and thickened medial base covered with dense long, fine setae. *Mandible* (Fig. 3) palp length 0.83 mandible length. Left spine row with 12 spines, 6 of which are bifurcate. Right spine row with 11 spines, 5 of which are bifurcate. Molar process length subequal to width; with 1 tooth, fine simple setae forming posterior row (implicit character state: dense along posterolateral margin). *Maxillula* (Fig. 4B) medial lobe length 0.82 lateral lobe length; width 0.63 lateral lobe width; with 4 pappose setae; with 1 "accessory" seta, on distolateral margin, "accessory" setae simple; with 1 short weakly setulate seta on distal tip (weakly serrate). Lateral lobe distal margin with 8 denticulate robust setae, with 5 smooth robust setae; ventral face with 3 plumose setae (although only 1 of these appears to have setules on both margins). *Maxilla* (Fig. 4C) medial lobe width 1.52 outer lateral lobe width; proximal portion smoothly continuous with distal portion; proximal and distal setal rows continuous. Outer lateral lobe longer than inner lateral lobe, width subequal to inner lateral lobe. *Maxilliped* (Fig. 4D–F) epipod distal tip rounded. Endite medial margin with 3 coupling hooks on left side, 4 on right side; dorsal ridge with 24 large distally denticulate plumose setae (approximately, 8 are only distally denticulate, with one row of fine setules).

Figure 2. *Eremisopus beei* n.gen., n.sp. A,E,F,G(enlargement), paratype ♀ (AM P61455); B–D,G, paratype ♂ (AM P61454). A, head, lateral view; B, antennula; C,D, antenna, with enlargements of basal and proximal articles; E–G, pleotelson, lateral, ventral and dorsal views, with enlargements of uropods and dorsal surface. Scale bar 1 mm.

Pereopod I (Fig. 5A–D) dactylus ventrodistal margin smooth, with one distal accessory claw (heavy setae), distal accessory spines absent. Propodus dorsal margin proximal region protruding beyond distodorsal margin of carpus. Propodal palm convex to straight, spine-like projections absent; cuticular fringe weakly developed; stout denticulate

Figure 3. *Eremisopus beei* n.gen., n.sp. A,C–J, paratype ♂ (AM P61453); paratype ♂ (AM P61454) B. A–F, right mandible; G–J, left mandible. Scale bar 0.5 mm.

setae absent; stout robust simple setae conical; elongate broad based setae absent. Merus dorsal margin projection shelf-like and U-shaped, with 1 or 2 robust simple setae. Basis ventrodistal margin elongate setae absent. *Pereopods II–III* (Fig. 6A,B) dactylus without spines on ventral margin; with 1 distal accessory claw. Propodus articular plate present. Basis dorsal ridge in cross section angular and produced but not forming distinct plate. *Pereopod IV* (Fig.

Figure 4. *Eremisopus beei* n.gen., n.sp. Paratype ♂ (AM P61454). A, paragnaths; B, maxillula; C, maxilla; D–F, maxilliped. Scale bar 0.5 mm.

6C–E) subchelate with major hinges on dactylus-propodus. Dactylus length subequal to propodal palm (shorter in female). Propodus with 8–10 broad based setae on ventral margin, 2 distinctly larger than others; subequal in length to dactylar claw. Basis dorsal ridge in cross section angular and produced but not forming distinct plate. *Pereopods V–VII* (Fig. 6F–J) dactylus with 1 distal accessory claw; spines absent. Propodus articular plate on posterior side of limb present. Basis dorsal ridge distinctly separated from basis shaft, in cross section produced and forming distinct plate. Pereopod VII basis dorsal ridge distal margin rounded. *Penes* (Fig. 6I) curved posteriorly; length 0.18 body width at pereonite 7, extending to midline; smooth, lacking setae, distally tubular; distal tip rounded. *Pleopod* (Figs. 5H, 7)

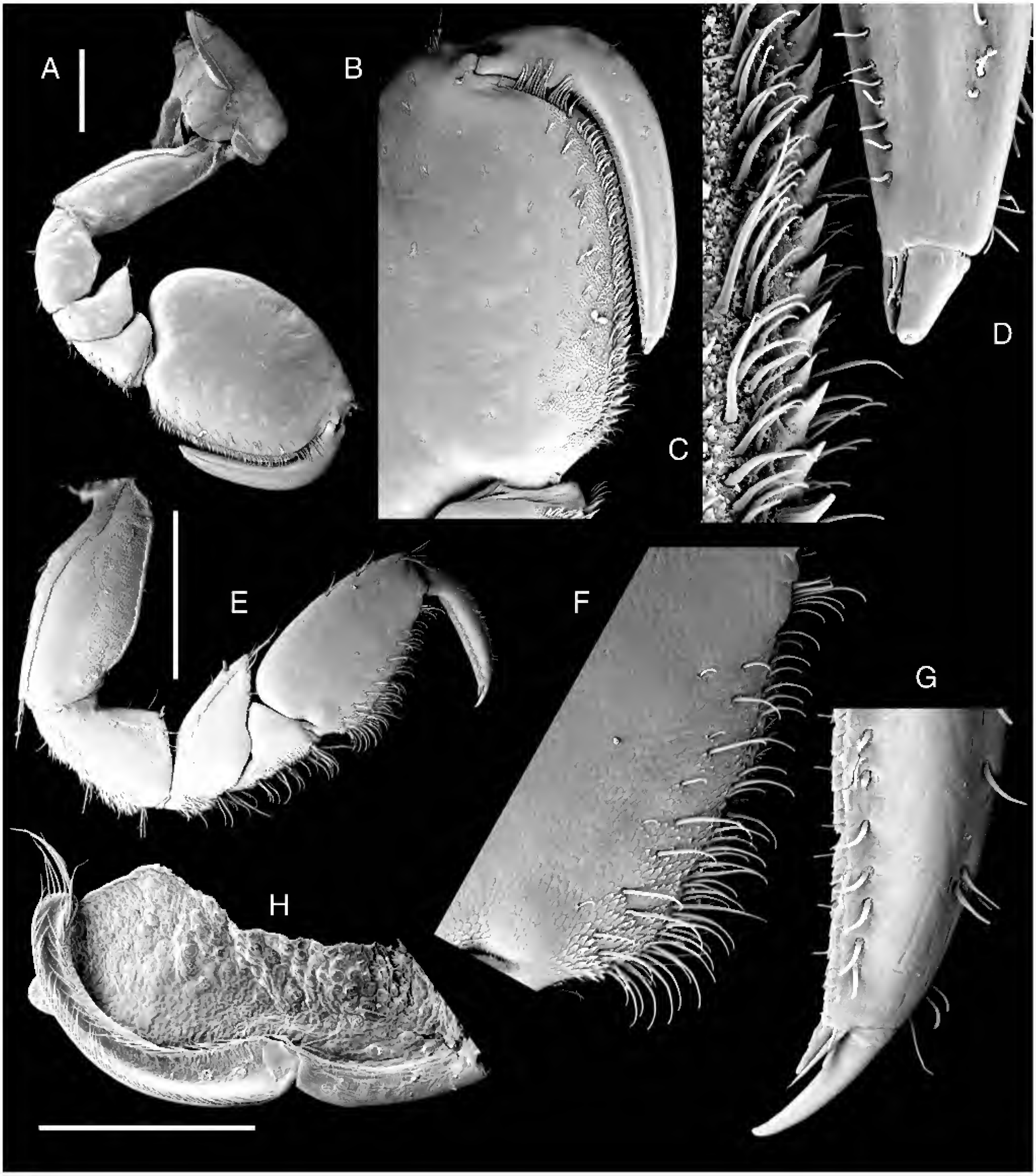

Figure 5. *Eremisopus beei* n.gen., n.sp. Paratype ♂ (AM P61454); paratype ♀ (AM P61455). A–D, ♂ pereopod I; E–G, ♀ pereopod I; H, ♂ pleopod II appendix masculina and endopod. Scale bar 1 mm.

exopods lateral proximal lobes on II–V, medial proximal lobes on II–V. Endopods I–V with setae on margins (sparse, on lateral proximal margin only), setae simple on all (mixed with minutely serrate setae). Protopods II–V with medial epipods; protopod II lateral epipods lobe-like. Pleopod I exopod broadest proximally, distal margin rounded, lateral margin rounded, dorsal surface lacking setae. Pleopod II endopod appendix masculina shaft proximal half ventral shape in cross section concave, not forming tube; basal musculature not pronounced (present but comparatively weak); distal tip broadly rounded; with 99 setae on margin (approximately), occurring laterally and medially; length 0.32 pleopod length, distal tip extending near to distal margin of endopod. *Uropod* (Figs. 1A, 2E–G) total length 1.14 pleotelson length. Protopod length 0.42 uropod total length; dorsomedial ridge produced, plate-like, margin smooth, margin setae robust and simple; with 2 robust spinose setae on distoventral margin, without robust simple setae on distoventral margin. Rami cross-sectional shape flattened on dorsal surface only. Endopod longer than

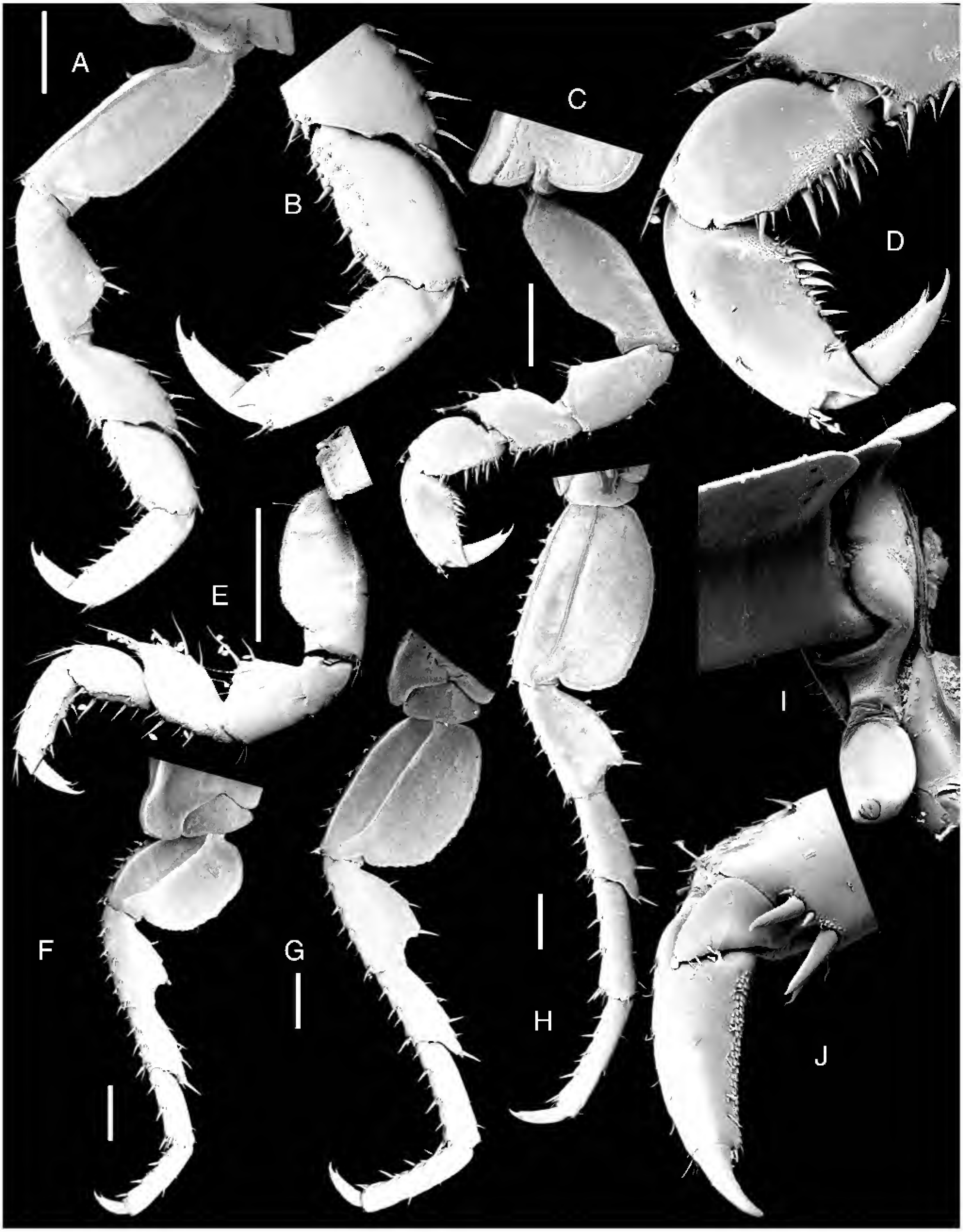

Figure 6. *Eremisopus beei* n.gen., n.sp. Paratype ♂ (AM P61454); paratype ♀ (AM P61455). A,B, ♂ pereopod II; C,D, ♂ pereopod IV; E, ♀ pereopod IV; F,G, ♂ pereopods V–VI; H–J, ♂ pereopod VII. Scale bar 1 mm.

protopod, straight-curving dorsally; dorsal margin robust setae placed midlength, 3–6 robust setae (3 laterally, 6 medially). Exopod length 0.84 endopod length; with 4 robust setae.

Sexual dimorphism, differences of female from male. *Antennula* with 12 articles. *Antenna* flagellum length 0.68 total antenna length, with 26 articles; proximal articles lacking dense cuticular hairs. *Pereopod I* dactylus

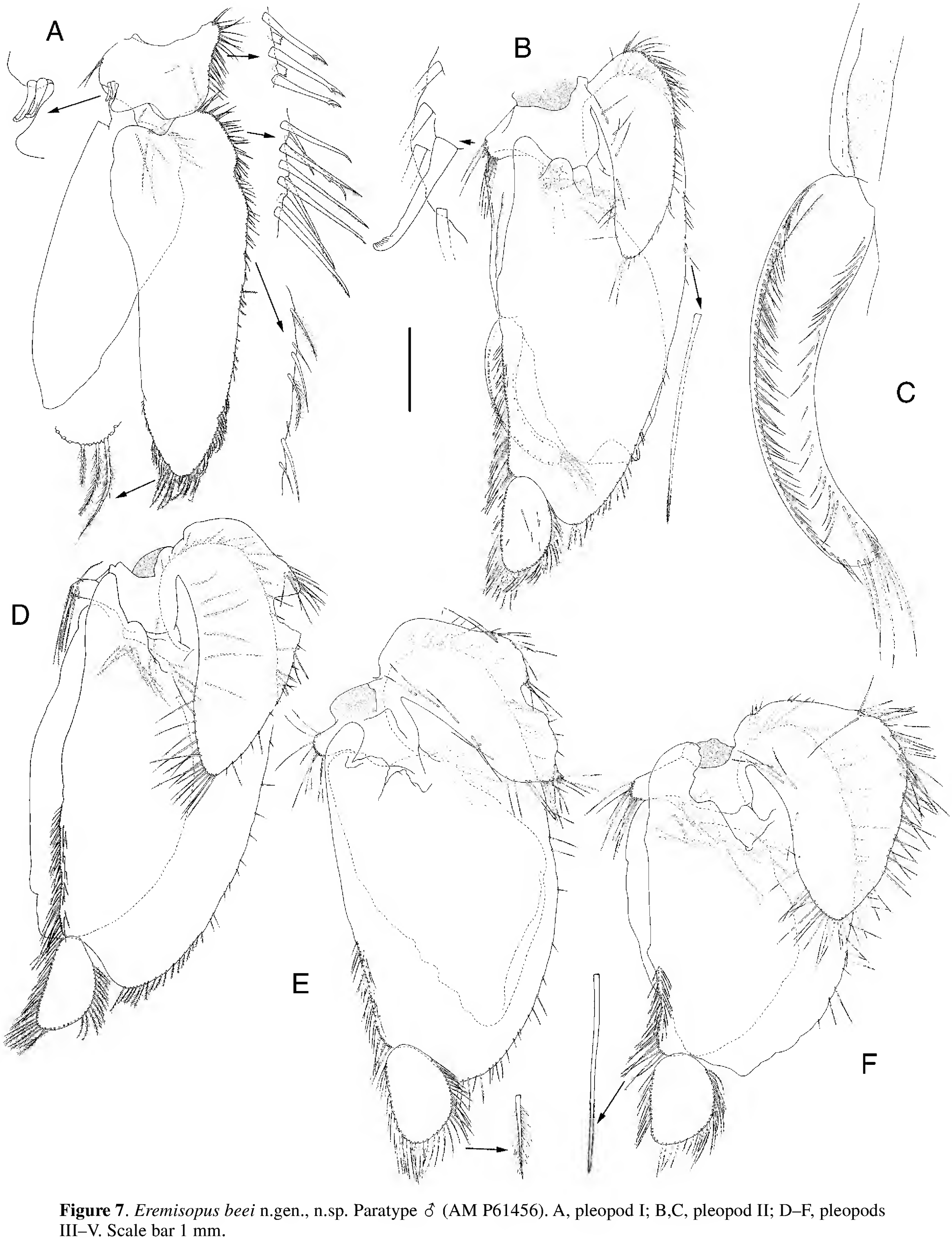

Figure 7. *Eremisopus beei* n.gen., n.sp. Paratype ♂ (AM P61456). A, pleopod I; B,C, pleopod II; D–F, pleopods III–V. Scale bar 1 mm.

ventrodistal margin with row of thin scale-like spines, along 0.56 total length; propodus dorsal margin proximal region not protruding beyond distodorsal margin of carpus. *Pereopod IV* propodus with 5 broad based setae on ventral margin. *Uropod* total length 0.96 pleotelson length; endopod with 2–7 robust setae (2 laterally, 7 medially); exopod length 0.86 endopod length, 3 robust setae.

Remarks. Some specimens of *Eremisopus beei* n.gen., n.sp. were reddish, owing to red pigments (possibly iron oxides) from the substrate adhering to their cuticle. Mr Cameron Bee brought numerous specimens back from a May 1997 field trip to the Kimberley. He kept his specimens in an aquarium for over a year with various native fishes. We also kept several specimens in a small unheated tank in our

laboratory from late May 1997 until January 1998. During this time, a brooding female released several young and moulted to a preparatory condition. Despite their limited distribution in the wild, these animals appear to tolerate a broad range of environmental conditions in the laboratory. In the aquaria, these animals were active and, when disturbed, swam using strong strokes of the pleopods and running motions of the anterior pereopods.

General distribution and habitat. "South Creek", near Kalumburu, Western Australia; fine sand and gravel, under rocks.

Peludo n.gen.

"New Genus 2": Wilson & Johnson, 1999: 265, fig. 1.
"New Genus X2": Wilson & Keable, 2001, table 1.

Type species. *Peludo paraliotus* n.sp.

Etymology. "*Peludo*" is a Spanish word meaning "hairy", suggested by the resemblance of this taxon to the furry donkey in Juan Ramón Jiménez's prose poem "Platero y Yo". The gender is interpreted to be masculine.

Diagnosis. External body surfaces covered with fine cuticular hairs, forming dense "fur", except for tuberculate dorsal midline. Head antennal notch deep, extending completely under eye; head length shorter than width in dorsal view, with several tubercles. Pleotelson strongly curled under body, pleopodal cavity facing anteriorly; posterior margin medial lobe reflexed against dorsal surface, triangular in posterior view; lateral lobes plate-like, shallower than basal width of uropod protopods; postanal ridge forming thin curved ring at edge of anal margin, lacking setae; dorsal uropod ridge elongate. Mandible palp length 0.4 mandible body length; article 1 forming thin ring, barely visible. Pereopodal dactyls proximally constricted, distally thin and sharp. Pleopod epipods without coupling hooks; exopods I–II strongly concave laterally. Uropod protopod dorsomedial plate broader than shaft, covering anus, lacking marginal setae.

Remarks. *Peludo* n.gen. is one of the more unusual taxa in the Amphisopodidae. Its reduced mandibular palp occurs nowhere else among the Phreatoicidea. The cuticular hairs, which cover the body, are usually seen only at high magnification and on scattered parts of the body in other phreatoicideans, examples include the basal part of the antennal flagellum in *Eremisopus* n.gen., and on the pleotelson (and elsewhere) in species of a new genus from the Grampians, Victoria (Wilson & Keable, in press). In *Peludo*, however, these hairs are macroscopic and dense. The deep antennal notch of *Peludo* extends well under the eye, giving it an almost pedunculate appearance (e.g., Fig. 8E); the eye of other phreatoicideans is more clearly fused to the head. The pleotelson of *Peludo* is so strongly curled under the body that it cannot be fully straightened, at least in preserved specimens, whereas most other phreatoicideans are capable of fully extending the pleon (pleonites and pleotelson). Figure 8B shows a live animal with the maximum extent of pleon extension. The pleotelson and uropods appear to close off the pleopodal and anal chambers (see Fig. 9A–C; the uropods in Fig. 9E,G,H were artificially spread to allow a ventral view of the pleotelson tip). The pleotelson distal tip of *Peludo*, flattened against the posterior surface of the pleotelson, superficially approximates the condition in *Platypyga* n.gen., although these two taxa have decidedly different forms of this structure. The pereopod I merus of *Peludo* overhangs from the carpus to the propodus, appearing longer than in other taxa such as *Crenisopus, Phreatoicus* Chilton, 1883 and *Crenoicus*.

Peludo paraliotus n.sp.

Figs. 8–14

Type material. HOLOTYPE ♂, WAM C 25051, bl (body length) 34.1 mm (formalin preserved). PARATYPES: formalin preserved—WAM C 25052, ♂ bl 24.3 mm, ♀ bl 19.3 mm, ♀ bl 16.6 mm; AM P60532, 11 ♂♂, 3 ♀♀, 12 indeterminate specimens; AM P61461, ♂ bl 26.1 mm (dissected for SEM); AM P61556, ♀ bl 19.6 mm (dissected for SEM); AM P61557, ♂ bl 28.9 mm (dissected for description and also illustration of pleopods); AM P61558, ♀ bl 22.3 mm (dissected for description and also illustration of pleopods); ethanol preserved—AM P60533, 26 ♂♂, 3 ♀♀, 14 indeterminate specimens—all from type locality, hand and hand sieves, pH 6.57, 11.8°C, G. Wilson, R. Wetzer & S. Keable, 6 September 1999, WA-597.

Type locality. Stream flowing from swamp at road crossing to le Grand Beach, Cape le Grand National Park, Western Australia, 33°58.75'S 122°07.23'E (GPS), under rocks and log, among base of reeds.

Other material. WAM C 21976 (WAM 28–95), ♂ bl 35.5 mm, Cape le Grand National Park, Western Australia, B. Knott, 20 May 1977; series from Cape le Grand National Park, Western Australia, G. Wilson, R. Wetzer & S. Keable, preserved in 95% ethanol—AM P60534, 19 ♂♂, 3 ♀♀, 65 indeterminate specimens, freshwater creek flowing into Hellfire Bay, 34°00.18'S 122°09.63'E (GPS), reed roots and rocks on edge of gully, sandy substrate (no mud), along steep side of gully 50–75 m from beach, hand sieves, pH 6.7, 17°C, 5 September 1999, WA-591; AM P60535, 1 ♂, 2 ♀♀, 1 indeterminate specimen, *Juncus* swamp/peat land behind Hellfire Bay, 33°59.99'S 122°09.72'E (GPS), silty wet substrate among roots of *Juncus*, hand sieves, 5 September 1999, WA-593; AM P60536, 2 ♂♂, 3 ♀♀, 7 indeterminate specimens, perennial *Juncus* swamp east of Hellfire Bay, 34°00.06'S 122°10.02'E (GPS), hand sieves, 6 September 1999, WA-596.

Etymology. The Greek species name "*paraliotus*" means "an inhabitant of the seacoast".

Diagnosis. See generic diagnosis.

Description based on male. *Colouration* in life, dark reddish brown, same colour as substrate. In 95% ethanol, dorsal surfaces of head, pereon and pleon grey mottled with pink, lateral surfaces of head, pereon and pleon, and dorsal surface of pleotelson, with dense "fur" of cuticular hairs trapping brown sediment, some pink cuticle exposed on pereopods. When cleaned, lateral surfaces and appendages mostly pink, mottled with grey.

Head (Fig. 8A,C–E) length shorter than width in dorsal view; width 0.78 pereonite 1 width; lateral profile of dorsal surface smoothly curved; setae absent. Eyes bulging dorsolaterally; maximum diameter 0.24 head depth; dorsal margin convex, ventral margin concave; orientation of longest axis horizontal; ocelli distinguishable as individual

Figure 8. *Peludo paraliotus* n.gen., n.sp. A, holotype ♂ (WAM C 25051); B, living paratype at type locality (specimen among AM P60532/3); C–E, paratype ♀ (AM P61556); F,G, paratype ♂ (AM P61461). A, lateral view; B, dorsal view; C–E, head; F, antenna; G, antennula. Scale bar 1 mm.

units, pigmentation dark. Cervical groove smoothly curved, extending nearly to dorsal margin of head. Mandibular groove present. Mandibular notch present. Clypeal notch present. *Pereon* (Fig. 8A) broad, width exceeding head width; dorsal surface with scattered tubercles and with transverse ridges; setae on dorsal surface absent. Pereonites

Figure 9. *Peludo paraliotus* n.gen., n.sp. A–C,F, paratype ♂ (AM P61461); D,E,G,H, paratype ♀ (AM P61556). A–H, pleotelson and uropods. Scale bar 1 mm.

2–7 in dorsal view wider than long. Coxal articulation of pereonites 2–4 nearly fused, 5–7 free (although coxa 5 partially fused). Sternal process occurring on sternite 7 (more pronounced in female). Typhlosole absent, gut round in cross section; hindgut caecae absent. *Pleonites* (Fig. 9A–C) in dorsal view 2–4 respective lengths more than half the length of pleonite 5, 1–4 relative lengths unequal, pleonite 4 length greater than pleonites 1–3, 1–4 width 0.78 composite length in dorsal view. *Pleotelson* (Figs. 8A, 9) lateral length 0.12 body length, 0.66 depth; dorsal length 1.18 width; depth 1.23 pereonite 7 depth. Posterior margin entire, reflexed dorsally, without irregular denticulations; median lobe width 0.5 pleotelson width, produced, greatest length 0.05 pleotelson total length; lateral lobes forming vertical plates, narrower than median lobe, distinct from median lobe, extending beyond median lobe, medial length 0.1 pleotelson total length; median lobe robust sensillate setae absent; lateral lobes robust sensillate setae absent.

Figure 10. *Peludo paraliotus* n.gen., n.sp. Paratype ♂ (AM P61461). A,D,G,H, left mandible; B,C,E,F, right mandible. Scale bar 0.5 m.

Dorsal uropodal ridge without setae. Ventral margin anterior to uropods with robust setae, setae denticulate, 7 altogether, posterior seta subequal to anterior adjacent setae. *Antennula* (Fig. 8G) length 0.09 body length, with 12 articles. Tiny aesthetascs on article 7 to terminal article. Terminal article distally oblique, with 2 or more groups of aesthetascs (tiny).

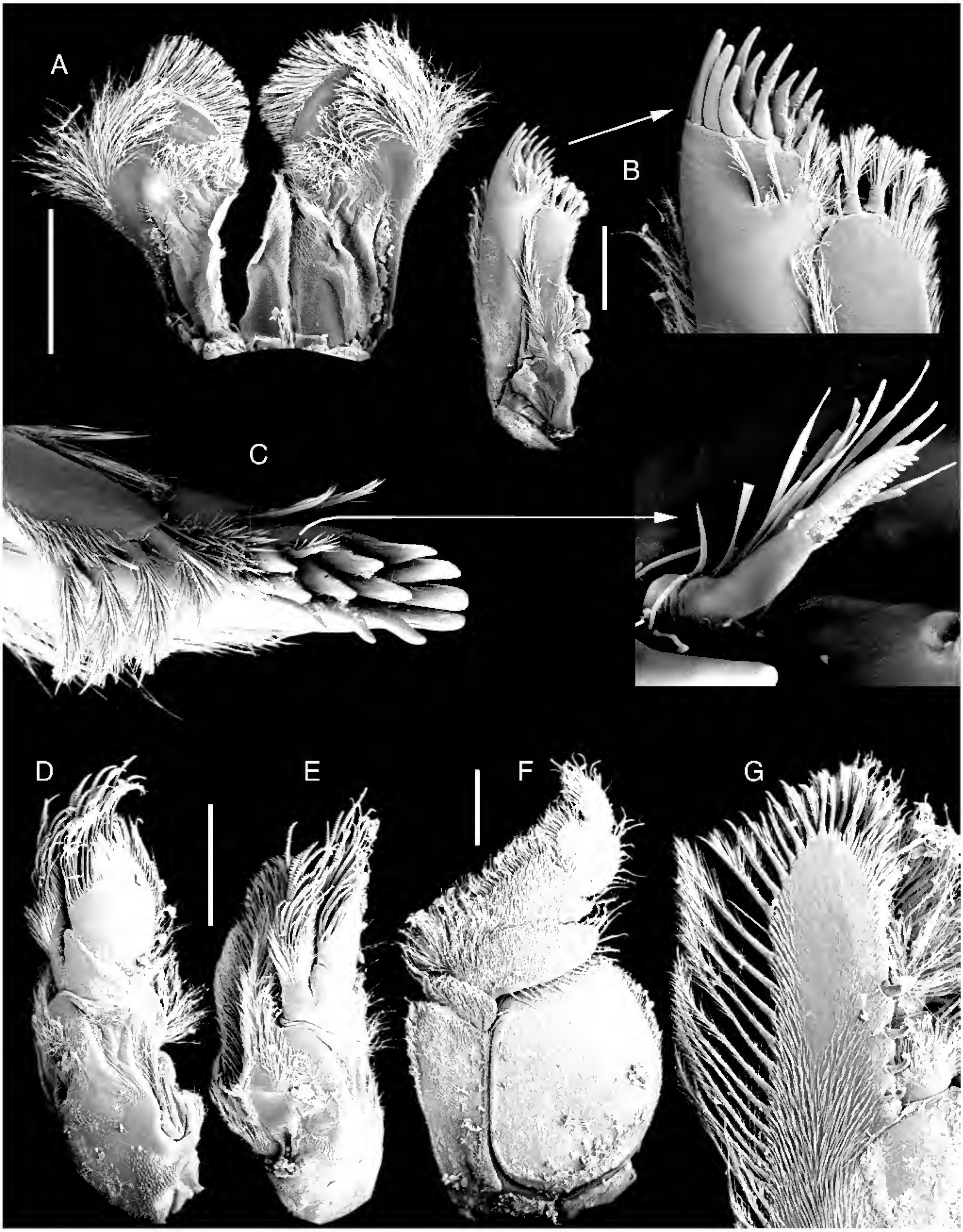

Figure 11. *Peludo paraliotus* n.gen., n.sp. Paratype ♂ (AM P61461). A, paragnaths; B,C, maxillula; D,E, maxilla; F,G, maxilliped. Scale bar 0.5 mm.

Penultimate article length approximately subequal to length of other articles. Distal articles circular. *Antenna* (Fig. 8F) length 0.26 body length. Flagellum length 0.59 total antenna length, with 20 articles. Propodal article 1 absent. Article 5 shorter than article 4, article 6 shorter than articles 4 and 5 combined. *Mouthfield* (Fig. 8C,D) clypeus consisting of

Figure 12. *Peludo paraliotus* n.gen., n.sp. Paratype ♂ (AM P61461); paratype ♀ (AM P61556). A,B, ♂ pereopod I; C,D, ♀ pereopod I; E, ♂ pleopod II appendix masculina. Scale bar 1 mm.

broad bar rounded at mandibular fossae, width 0.56 head width. Labrum ventrally semicircular in anterior view, asymmetrical, broadest on right side. Paragnaths (Fig. 11A) with distolaterally rounded lobes, having medial and lateral setal rows and thickened medial base covered with cuticular spinules. *Mandible* (Fig. 10) left spine row with 16 spines (approximately), 6 of which are bifurcate. Right spine row with 14 spines (approximately), 5 of which are bifurcate. Molar process with 1 tooth, complex setulate setae forming posterior row (plumose). *Maxillula* (Fig. 11B,C) medial lobe length 0.85 lateral lobe length; width 0.7 lateral lobe width; with 4 pappose setae; with 2 "accessory" setae, one on distolateral margin and one between central pappose setae, "accessory" setae simple; short weakly setulate seta on distal tip absent. Lateral lobe distal margin with 7 denticulate robust setae, with 6 smooth robust setae; ventral face with 2 plumose setae. *Maxilla* (Fig. 11D,E) medial lobe width 0.78 outer lateral lobe width; proximal portion smoothly continuous with distal portion; proximal and distal setal rows continuous. Outer lateral lobe length subequal to inner lateral lobe, wider than inner lateral lobe. *Maxilliped* (Fig. 11F,G) epipod distal tip pointed. Endite medial margin with

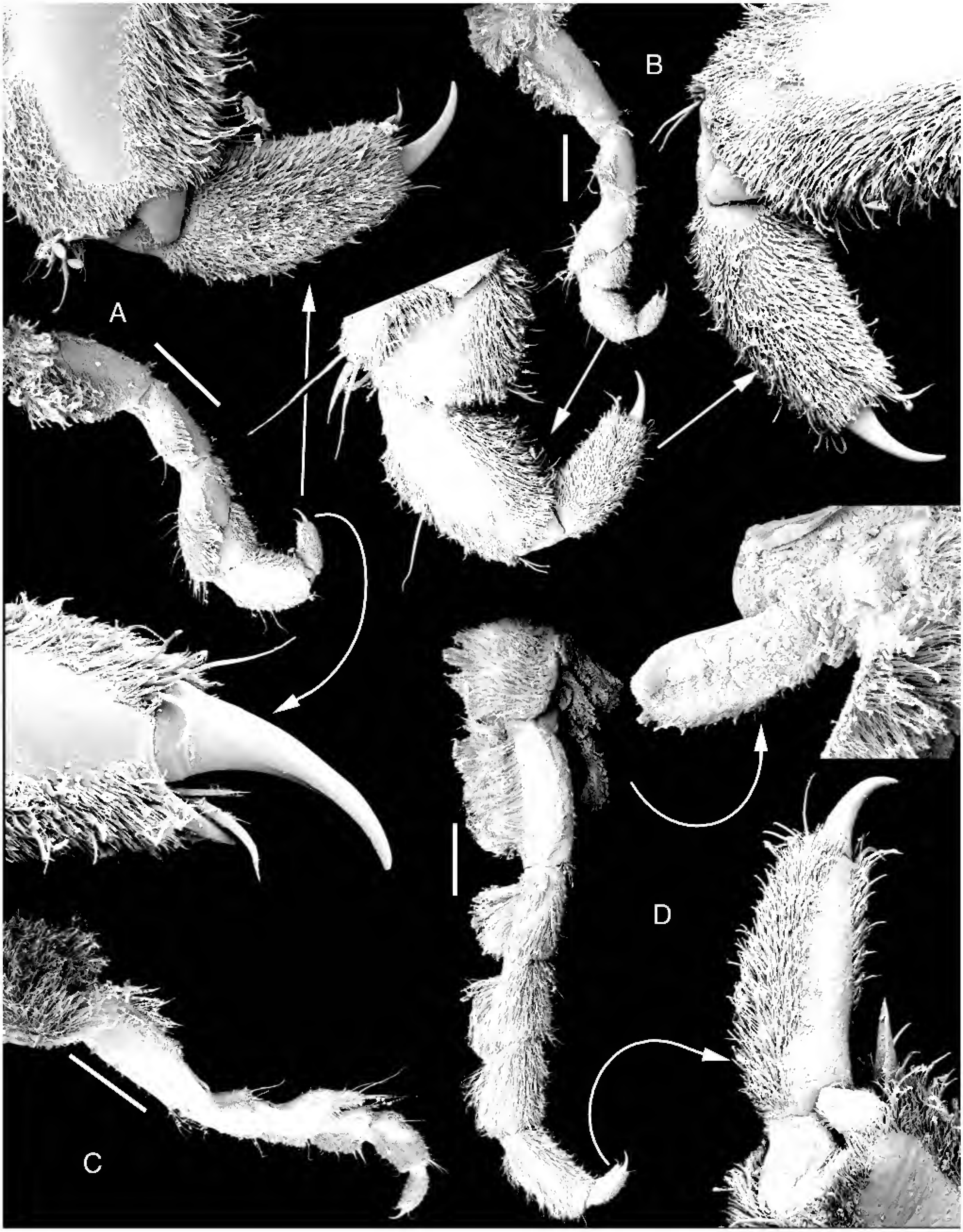

Figure 13. *Peludo paraliotus* n.gen., n.sp. Paratype ♂ (AM P61461); paratype ♀ (AM P61556). A, ♂ pereopod II; B, ♂ pereopod IV; C, ♀ pereopod IV; D, ♂ pereopod VII, with penes and articular plate. Scale bar 1 mm.

4 coupling hooks on left side, 4 on right side; dorsal ridge with 26 large distally denticulate plumose setae (but only distal setae denticulate). *Pereopod I* (Fig. 12A–D) dactylus length subequal to palm; ventrodistal margin smooth; with 2 distal accessory claws; distal accessory spines absent. Propodus dorsal margin proximal region not protruding. Propodal palm concave, spine-like projections absent; cuticular fringe weakly developed; stout denticulate setae

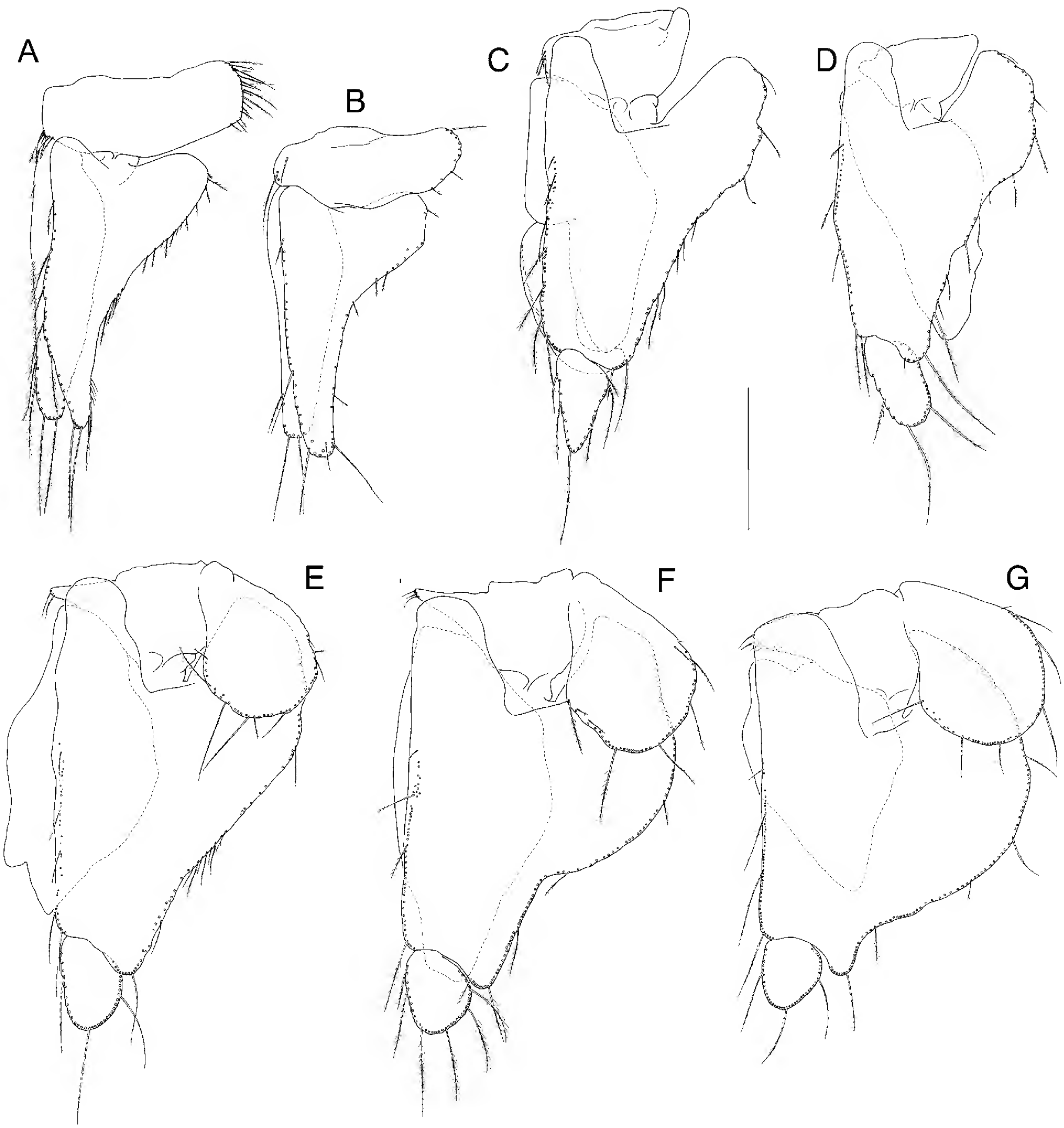

Figure 14. *Peludo paraliotus* n.gen., n.sp. A,C,E–G, paratype ♂ (AM P61557); B,D, paratype ♀ (AM P61558). A,B, pleopod I; C,D, pleopod II; E–G, pleopods III–V. Scale bar 1 mm.

absent; stout robust simple setae conical, 19 altogether; with 20 elongate broad based setae. Merus dorsal margin projection shelf-like and U-shaped (but approaching a spine-like condition), with numerous elongate simple setae. *Pereopods II–III* (Fig. 13A) dactylus without spines on ventral margin; with 1 distal accessory claw. Propodus articular plate present. Basis dorsal ridge in cross section produced and forming distinct plate. *Pereopod IV* (Fig. 13B,C) simple, not prehensile. Dactylus length subequal to propodal palm. Propodus with 12 broad based setae on ventral margin, 1 distinctly larger than others; shorter than dactylar claw. Basis dorsal ridge in cross section angular and produced but not forming distinct plate. *Pereopods V–VII* (Fig. 13D) dactylus with 1 distal accessory claw; spines absent. Propodus articular plate on posterior side of limb present. Basis dorsal ridge distinctly separated from basis shaft, in cross section produced and forming distinct plate. Pereopod VII ischium dorsal ridge forming flange less than shaft width. *Penes* (Fig. 13D) curved posteriorly; length 0.23 body width at pereonite 7, extending past midline and onto pleonite 1; with cuticular hairs on shaft, distally tapering and broadening (broadest medially); distal tip flattened and truncate. *Pleopod* (Figs. 9C,F, 12E, 14) exopods with lateral proximal lobes on I–V (extending laterally but not extending proximally along protopod on pleopod I), medial proximal lobes on I–V (just extending on to protopod on pleopod I). Endopod I only with setae on margins, setae plumose. Protopods II–V with medial epipods; protopod I lateral epipods linear. Pleopod I exopod broadest proximally, distal margin rounded, dorsal surface lacking setae. Pleopod II endopod appendix masculina shaft proximal half ventral shape in cross section concave, not

forming tube; basal musculature pronounced; distal tip broadly rounded; with 51 setae on margin, occurring laterally and medially; length 0.68 pleopod length, distal tip extending near to distal margin of endopod. *Uropod* (Fig. 9) total length 0.97 pleotelson length. Protopod length 0.53 uropod total length; dorsomedial ridge produced, plate-like, margin smooth; dorsolateral margin setae absent; distoventral margin robust setae absent; ventral ridge without rows of long laterally projecting setae (implicit character state: abundant long "cuticular hairs" present). Rami distal tips pointed; cross-sectional shape round. Endopod longer than protopod, straight-curving dorsally; dorsal margin robust setae absent. Exopod length 0.87 endopod length; exopod dorsal margin robust setae absent.

Sexual dimorphism, female differences from male. *Antennula* with 11 articles. *Antenna* length 0.31 body length. *Pereopod I* dactylus ventrodistal margin with row of thin scale-like spines, along 0.44 total length; propodal palm with 23 elongate broad based setae. *Pereopod IV* propodus with 9 broad based setae on ventral margin. *Uropod* total length 1.1 pleotelson length, protopod length 0.55 uropod total length.

Remarks. The Hellfire Bay specimens (samples WA591–593) are not obviously different from those from the type locality. The largest specimens, however, are significantly smaller than those collected near Cape le Grand Beach. Nevertheless, all of our collections of this species from Cape le Grand National Park appear to be conspecific.

General distribution and habitat. Cape le Grand National Park, Western Australia; silty coastal wetlands including *Juncus* swamps and outflowing streams.

Platypyga n.gen.

"New Genus 4" Wilson & Johnson, 1999: 265, fig. 1.
"New Genus X4" Wilson & Keable, 2001, table 1.

Type species. *Platypyga subpetrae* n.sp.

Etymology. "*Platypyga*" is derived from the Greek words meaning "flat rump", which refers to the flattened posterior margin of the pleotelson.

Diagnosis. Body dorsal surfaces pitted especially on head, lacking elongate setae. Head lacking cervical groove. Pleotelson posterior margin with broad reflexed medial region, compressed toward anterior and dorsal margins, medially cleft, forming curved ridge between widely-separated dorsal projections, each with large robust setae; postanal ridge narrow, with fine setae. Pereopods V–VII with dorsal ridge plates narrower than basis shaft. Pleopod I protopod with coupling hooks. Uropod protopod ventral ridge with rows of laterally projecting long simple setae; dorsomedial plate absent; distoventral robust setae lacking denticles. Uropod rami distally rounded, with apical elongate robust setae.

Remarks. We homologise the unusual pleotelson posterior margin of *Platypyga* n.gen. with the cleft medial lobe found in *Synamphisopus* and *Phreatomerus*. Although we are uncertain, assuming that the two widely spread lobes are homologous to the medial lobe of the other taxa appears to be the simplest explanation. Thus, the small setose bumps on lateral margin just above the uropodal insertions may be homologous with the lateral lobes of other taxa. The posterior margin in *Platypyga*, however, lacks any definite demarcation between the larger, more dorsal lobes and this group of setae. Other taxa have groups of setae above the uropods, complicating this interpretation. Because of this uncertainty, we have not scored *Platypyga* as having lateral lobes. If, however, the dorsolateral pleotelson lobes of *Platypyga* are homologous with lateral lobes, phylogenetic analysis (research in progress) might place this taxon among the Phreatoicidae, despite its lacking phreatoicid mandibular (pedunculate spine row, absent right lacinia mobilis) and appendix masculina (generally rod-like) synapomorphies. This placement occurs because, unlike many amphisopodids, *Platypyga* also lacks a large dorsomedial plate on the uropodal protopod. The generalised appendix masculina of *Platypyga* (concave in proximal cross section, acutely rounded distally with a fringe of setae) is similar to other amphisopodids such as *Eremisopus* and *Peludo*, and may represent a plesiomorphic condition for the suborder. Consequently, *Platypyga* appears to have has a unique mixture of plesiomorphic and apomorphic features.

Platypyga subpetrae n.sp.

Figs. 15–22

Type material. HOLOTYPE ♂, WAM C 25053, bl 15.7 mm (ethanol preserved) hand sieve, G.D.F. Wilson, 8 October 1998, WA-564. PARATYPES: formalin preserved—AM P60537, 53 ♂♂, 1 indeterminate specimen, as for holotype except, 34°23.4'S 118°03.1'E, spring fed stream at base of scree slope, in silty gravel in pool on stream, hand sieves, pH 6.96, 11.0°C, G. Wilson, R. Wetzer & S. Keable, 9 September 1999, WA-603; AM P61460, ♂ 15.8 mm (dissected for SEM), collection details as for AM P60537; WAM C 25054, ♂ bl 18.2 mm, ♂ bl 14.3 mm, ♂ bl 13.9 mm, collection details as for AM P60537; ethanol preserved—AM P60538, 49 ♂♂, 5 ♀♀, same collection details as holotype; AM P61457, ♂ (dissected for SEM), same collection details as holotype; AM P61458, ♀ 7.4 mm (dissected for description, SEM and illustration of pleopods), same collection details as holotype; AM P61459, ♂ 13.7 mm (dissected for description and also illustration of pleopods), same collection details as holotype; AM P61559, 1 specimen (whole mounted for SEM), same collection details as holotype; AM P60539, 49 ♂♂, collection details as for AM P60537.

Type locality. Spring below Toolbrunup Peak, Western Australia, Australia, 34°23.41'S 118°02.98'E (GPS), 700m altitude, under rocks in sandy gravel, spring emerging at bottom of large scree slope.

Other material. WAM C 23271, ♂ bl 20 mm, Toolbrunup Peak, Stirling Range, Western Australia, 34°23.17'S 118°02.51'E, 1030m altitude (original data indicating Toolbrunup summit), from a southeast facing gully, S. Barrett, Department of Conservation and Land Management (CALM), 1996; AM P60540, 9 ♂♂, 5 ♀♀, 1 indeterminate specimen, spring in saddle on west side at head of stream running on south side of track, Bluff Knoll, Stirling Range, Western Australia, 34°22'S 118°15'E (map estimate), W.F. Ponder, January 1988.

Etymology. The species name "*subpetrae*" is a Latin genitive singular noun meaning "under a crag or pile of rocks", referring to the type locality at the base of a scree slope.

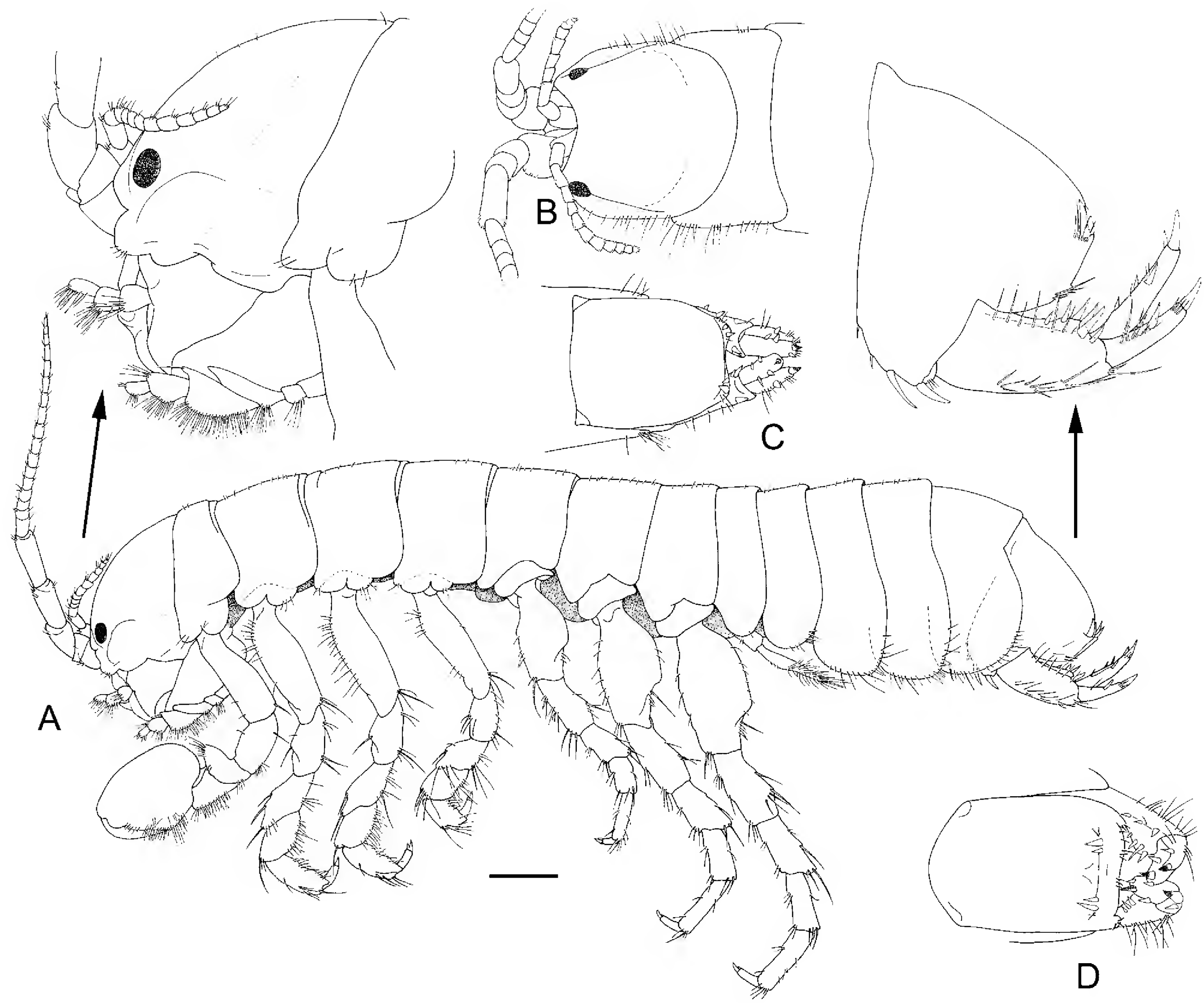

Figure 15. *Platypyga subpetrae* n.gen., n.sp. Holotype (WAM C 25053). A, lateral view with enlargements of head and pleotelson; B, head, dorsal view; C,D, pleotelson, dorsal and posterior views. Scale bar 1 mm.

Diagnosis. See generic diagnosis.

Description based on male. *Colouration* colourless in life, colour variable in specimens preserved in 95% ethanol—from slate grey-brown mottled with white to almost pure white with only slight brown-yellow tinges, gut a translucent turquoise visible through cuticle and particularly through sternites.

Head (Figs. 15A,B, 16A–C,E) length shorter than width in dorsal view; width 0.89–0.92 pereonite 1 width; lateral profile of dorsal surface smoothly curved; surface smooth and shiny; setae sparse, fine. Eyes bulging dorsolaterally (slight, the eye appears somewhat raised because of the strongly developed mandibular groove underneath it); maximum diameter 0.12–0.2 head depth; oval; orientation of longest axis vertical; ocelli not distinguishable as individual units, pigmentation dark and light (white background with variable black spots). Mandibular groove with acute indentation. Mandibular notch present. Clypeal notch present (weak). Antennal notch shallow, without posterior extension. *Pereon* (Figs. 15A, 16A) narrow, width near head width; dorsal surface with scattered roughness and smooth; setae on dorsal surface scattered, fine. Pereonites 2–7 in dorsal view wider than long. Coxal articulation of pereonites 2–4 nearly fused (lateral suture weak but complete), 5–7 free. Sternal processes absent. Typhlosole absent, gut round in cross section; hindgut caecae absent. *Pleonites* (Figs. 15A, 16A) in dorsal view 2–4 respective lengths more than half the length of pleonite 5, 1–4 relative lengths subequal, 1–4 width 0.85 composite length in dorsal view. *Pleotelson* (Figs. 15A,C,D, 21A–C) lateral length 0.11 body length, 0.94 depth; dorsal length 1.2 width; depth 1.48 pereonite 7 depth. Posterior margin without irregular denticulations; median lobe width 0.69 pleotelson width, greatest length 0.05 pleotelson total length; lateral lobes absent; median lobe with 2 robust sensillate setae on one of the cleft pair. Dorsal uropodal ridge terminating at pleotelson margin above uropods (implicit character state: short, weak); without setae. Ventral margin anterior to uropods with robust setae, setae smooth, 3 altogether, posterior seta smaller than anterior adjacent setae (thicker but shorter). *Antennula* (Fig. 16C,D) length 0.11 body length, with 12 articles. Tiny aesthetascs on articles 9, 11, 12. Terminal article distally oblique, with 2 or more groups of aesthetascs, length subequal to penultimate article length. Penultimate article length approximately subequal to length of other articles. Distal articles circular. *Antenna* (Figs. 15A, 16A,E–G) length 0.37 body length. Flagellum

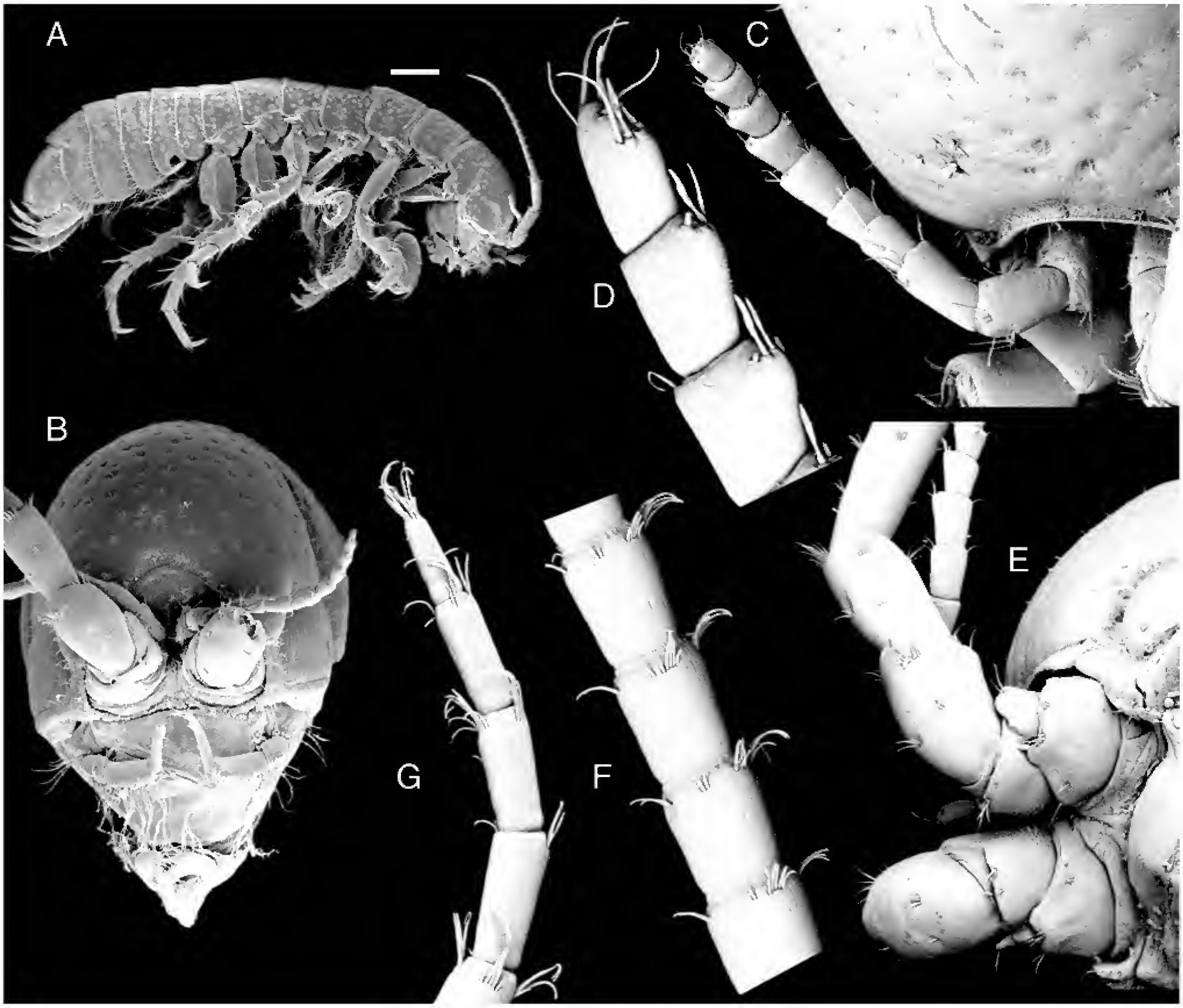

Figure 16. *Platypyga subpetrae* n.gen., n.sp. A,B, paratype (AM P61559); C–E, paratype ♂ (AM P61457). A, body lateral view; B,C,E, head; D, antennula, distal articles; F, antenna proximal flagellar articles; G, antenna terminal flagellar articles. Scale bar 1 mm.

length 0.62 total antenna length, with 18 articles. Propodal article 1 absent. Article 5 longer than article 4, article 6 shorter than articles 4 and 5 combined. *Mouthfield* (Figs. 15A, 16B) clypeus consisting of broad bar rounded at mandibular fossae, somewhat asymmetrical, broader on left side and with concave lateral margin, width 0.53 head width. Labrum ventrally semicircular in anterior view, somewhat asymmetrical. Paragnaths (Fig. 18A) with distolaterally rounded lobes, having medial and lateral setal rows and thickened medial base covered with cuticular spinules. *Mandible* (Fig. 17) palp length 0.64 mandible length. Left spine row with 12 spines, 9 of which are bifurcate. Right spine row with 14 spines, 9 of which are bifurcate. Molar process length subequal to width; with 1 tooth. *Maxillula* (Fig. 18B,C) medial lobe length 0.82 lateral lobe length; width 0.68 lateral lobe width; with 4 pappose setae; with 2 "accessory" setae, one on distolateral margin and one between central pappose setae, "accessory" setae simple; short weakly setulate seta on distal tip absent. Lateral lobe distal margin with 9 denticulate robust setae, with 5 smooth robust setae; ventral face with 2 plumose setae. *Maxilla* (Fig. 18D,E) medial lobe width 1.4 outer lateral lobe width; proximal portion distinctly angled to distal portion; proximal and distal setal rows continuous. Outer lateral lobe length subequal to inner lateral lobe, wider than inner lateral lobe. *Maxilliped* (Fig. 18F,G) epipod distal tip truncate. Endite medial margin with 5 coupling hooks on left side, 4 on right side; dorsal ridge with 17 large distally denticulate plumose setae (approximately, very weakly denticulate distally). *Pereopod I* (Fig. 19A–D) dactylus length subequal to palm; ventrodistal margin with row of thin scale-like spines, along 0.46 total length; with 1 distal accessory claw; distal accessory spines absent. Propodus dorsal margin proximal region protruding beyond distodorsal margin of carpus. Propodal palm convex to straight, spine-like projections absent; cuticular fringe weakly developed; stout denticulate setae absent; stout robust simple setae basally inflated, 8 altogether (SEM); with 6 elongate broad based setae. Merus dorsal margin projection shelf-like and U-shaped, with numerous elongate simple setae and with 1 or 2 robust simple setae. *Pereopods II–III* (Fig. 20A,B) dactylus without spines on ventral margin; with 1 distal accessory claw. Propodus articular plate present. Basis dorsal ridge in cross section angular and produced but not forming distinct plate.

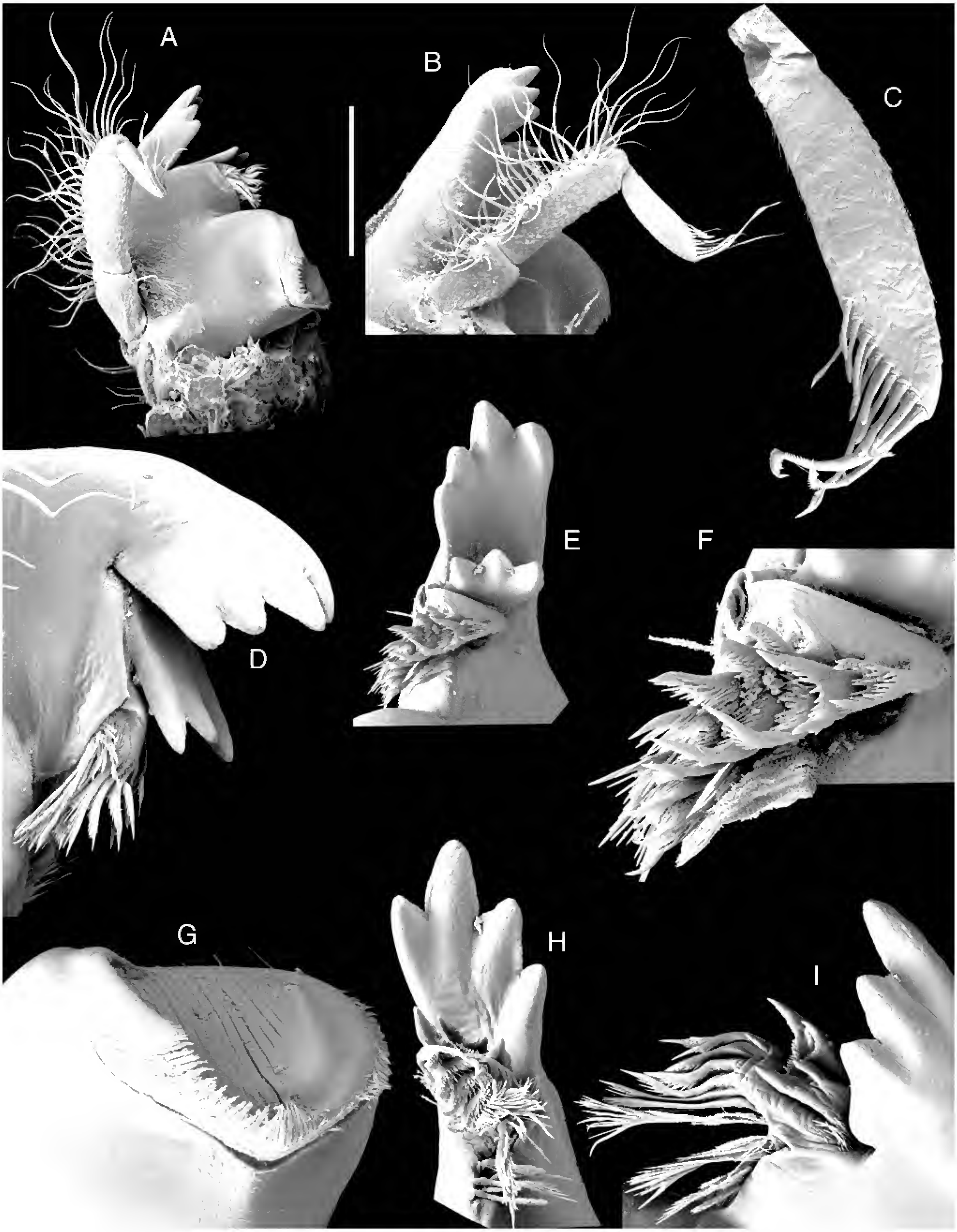

Figure 17. *Platypyga subpetrae* n.gen., n.sp. Paratype ♂ (AM P61460). A–G, right mandible; H,I, left mandible. Scale bar 0.5 mm.

Pereopod IV (Fig. 19E,F) subchelate with major hinges on dactylus-propodus (weakly). Dactylus shorter than propodal palm, or longer than propodal palm (shorter when measured on specimen, longer in SEM). Propodus with 1 broad based seta on ventral margin, shorter than dactylar claw (shorter when measured on specimen, subequal in SEM). Basis dorsal ridge in cross section angular and produced but not forming distinct plate. *Pereopods V–VII* (Fig. 20C–F)

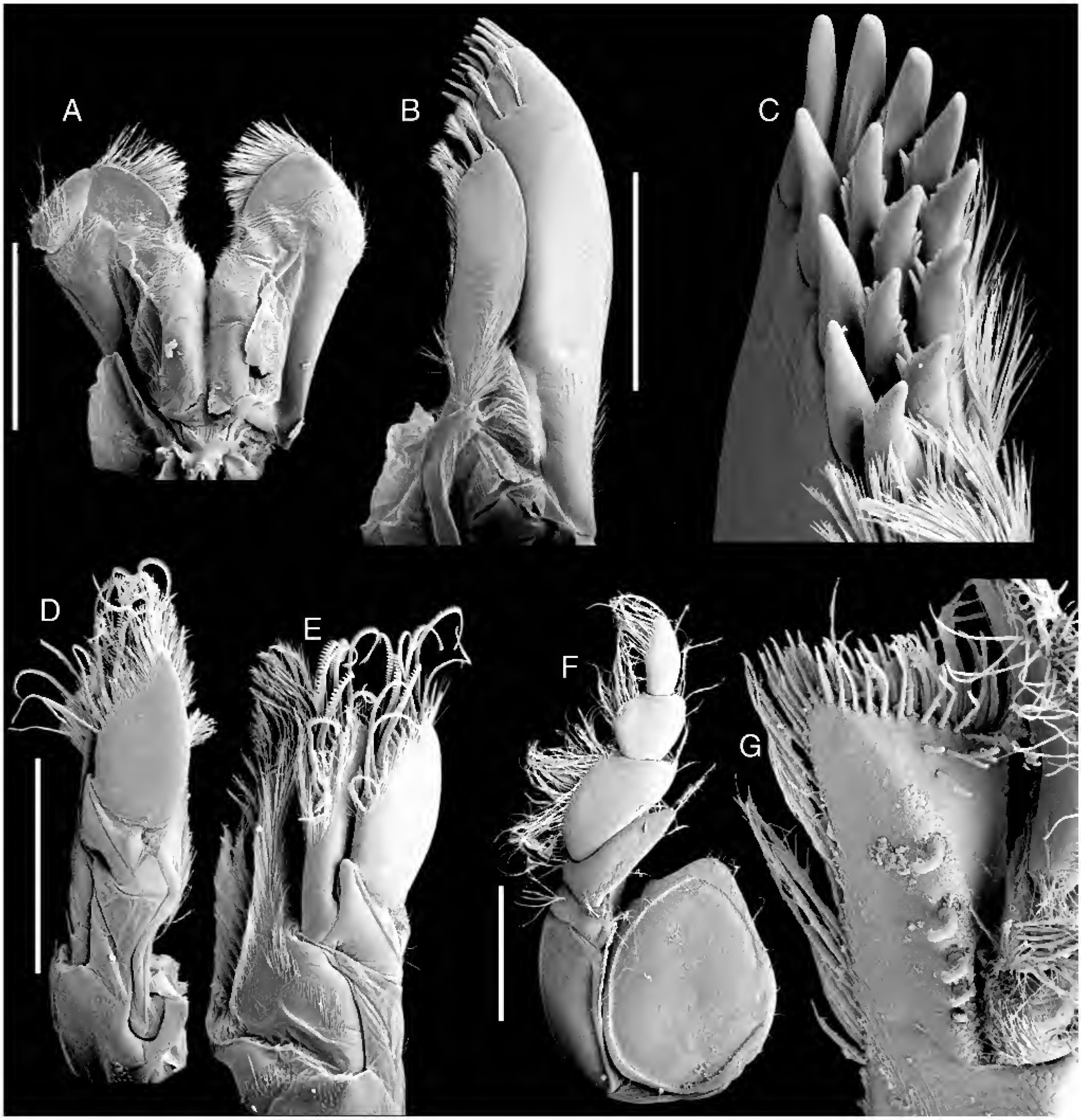

Figure 18. *Platypyga subpetrae* n.gen., n.sp. Paratype ♂ (AM P61460) A–E; paratype ♂ (AM P61457) F,G. A, paragnaths; B,C, maxillula; D,E, maxilla; F,G, maxilliped. Scale bar 0.5 mm.

dactylus with 1 distal accessory claw; spines absent. Propodus articular plate on posterior side of limb present. Basis dorsal ridge not distinctly separated from basis shaft, in cross section angular on pereopod V, produced and forming distinct plate on pereopods VI–VII. Pereopod VII ischium dorsal ridge flange absent. *Penes* (Fig. 20E) curved posteriorly; length 0.19 body width at pereonite 7, extending past midline and onto pleonite 1; smooth, lacking setae, distally tapering (broadest medially); distal tip rounded. *Pleopod* (Figs. 21E,F, 22) exopods lateral proximal lobes on II–V, medial proximal lobes on II–V. Endopods I–V without setae on margins. Protopods II–V with small medial projections, III–V with lateral epipods; 3–4 coupling hooks on I; lateral margin I with simple and lightly plumose setae, lateral margin II without setae, lateral epipods III–V with simple and lightly plumose setae; medial margin I without slender setae, medial margin/epipods II–V with simple setae. Pleopod I exopod broadest proximally, distal margin rounded, lateral margin rounded, dorsal surface lacking setae. Pleopod II endopod appendix masculina shaft proximal half ventral shape in cross section concave, not forming tube; basal musculature pronounced; distal tip acutely rounded; with 31 setae on margin, occurring laterally and medially; length 0.5 pleopod length, distal tip extending near to distal margin of endopod. *Uropod* (Fig. 21B–D) total length 1.21 pleotelson length. Protopod length 0.51 uropod total length; dorsomedial ridge not produced, margin setae robust and simple; with 1 robust simple seta on distoventral margin. Rami cross-sectional shape flattened on dorsal surface only. Endopod subequal to protopod

Figure 19. *Platypyga subpetrae* n.gen., n.sp. A,E, paratype ♂ (AM P61457); B,F, paratype ♀ (AM P61458); C,D, paratype ♂ (AM P61460). A, pereopod I, ♂; B, pereopod I, ♀; C,D, pereopod I, ♂; E,F, pereopod IV, ♂, ♀. Scale bar 0.5 mm.

length, straight-curving dorsally; dorsal margin robust setae placed midlength, 6 robust setae (3 medially, 3 laterally). Exopod length 0.88 endopod length; exopod dorsal margin with 1 robust seta.

Sexual dimorphism, female differences from male. *Antennula* length 0.1 body length, with 10 articles. *Antenna* length 0.35 body length; flagellum length 0.65 total antenna length, with 16 articles. *Pereopod I* dactylus ventrodistal

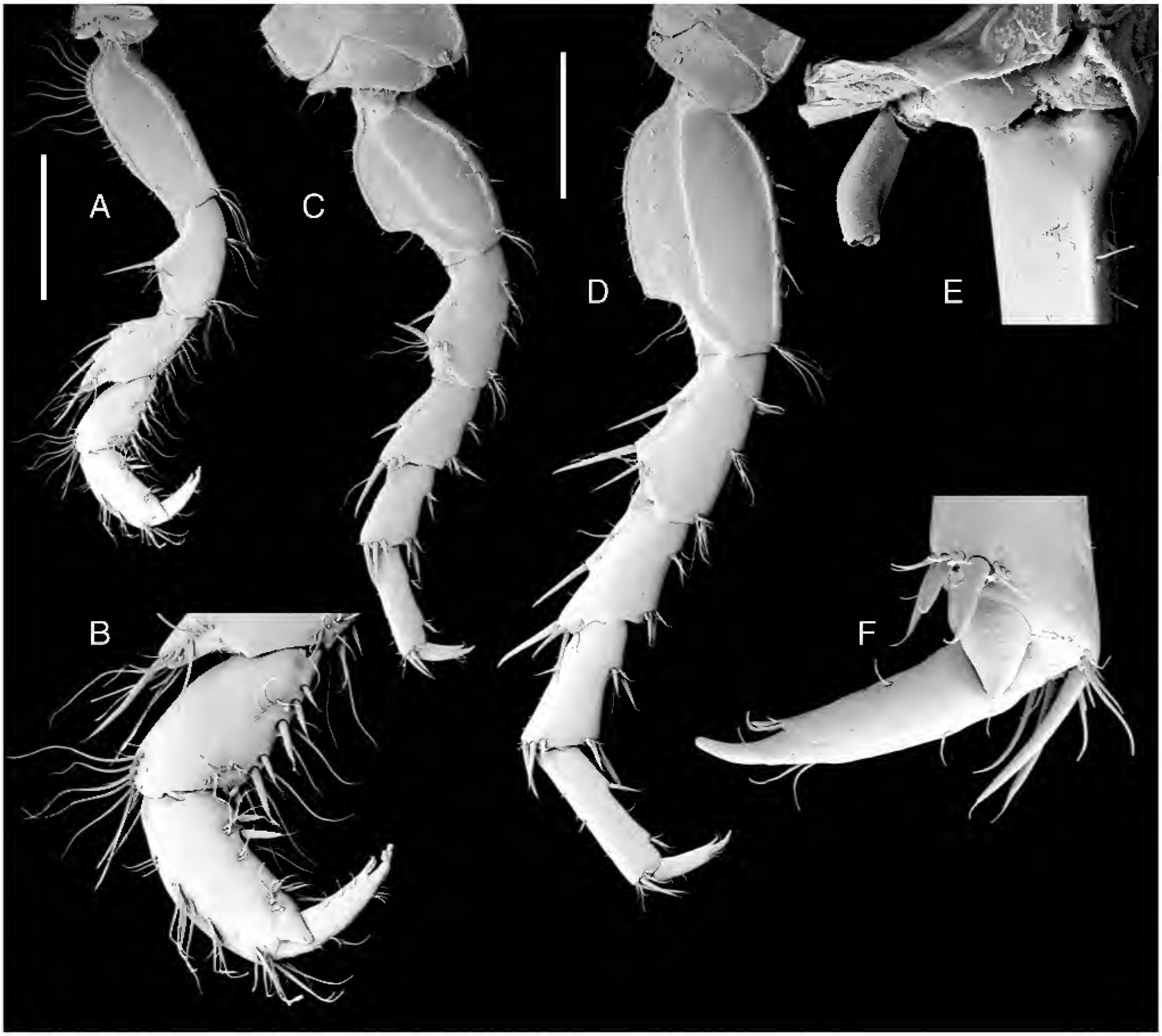

Figure 20. *Platypyga subpetrae* n.gen., n.sp. A,B, paratype ♂ (AM P61457); C–F, paratype ♂ (AM P61460). A,B, pereopod II; C, pereopod V; D–F, pereopod VII. Scale bar 1 mm.

margin with row of sharp spines, along 0.53 total length; propodus dorsal margin proximal region not protruding beyond distodorsal margin of carpus, propodal palm with stout serrate setae, 8 altogether; stout robust simple setae absent; with 2 elongate broad based setae. *Pereopod IV* propodus with 2 broad based setae on ventral margin. *Uropod* total length 1.16 pleotelson length; endopod with 7 robust setae (4 medially, 3 laterally); exopod length 0.72 endopod length.

Remarks. Females of *Platypyga subpetrae* n.gen., n.sp. in our two samples (WA-564, WA-603) are rare and smaller than males. These specimens are smaller than the males from WAM C 23271 or AM P60540 (Bluff Knoll specimens, W. Ponder collection). The latter collection has larger individuals (greater than 20 mm), with an increased number of robust setae on the terminal lobes of the pleotelson, than the WAM C 23271 specimen. These larger specimens also differ from the type material in having the uropodal endopod longer than protopod. This feature, however, is not readily discernible without careful measurements. Until further evidence is available, we assume that all material examined is conspecific.

General distribution and habitat. Stirling Range National Park, Western Australia; rocky spring-fed streams flowing from south-facing slopes of the highest peaks of the Range.

Discussion

Epibionts. Most phreatoicideans have many microscopic organisms living on the external cuticle. Loricate peritrichs (Ciliophoran "protozoans"), commonly occur on various parts of the body (e.g., Figs. 3A,D,E, 10B, 12C; Fernandez-Leborans & Tato-Porto, 2000; J. Clamp, pers. comm.). Recent examples include the Lagenophryidae genus *Operculigera* found on *Colubotelson joyneri* (Clamp, in preparation), as well as *Vorticella* on a new phreatoicid genus from the Grampians (Victoria) (Wilson & Keable, in press). Aloricate ciliophorans may attach as cysts on pleopods, observed in *Phreatoicus typicus* (Clamp, pers. comm.). Metazoans also use phreatoicideans as a substrate.

Figure 21. *Platypyga subpetrae* n.gen., n.sp. A, paratype (AM P61559); B,C, paratype ♂ (AM P61457); D, paratype ♀ (AM P61458); E,F, paratype ♂ (AM P61460). A, pleotelson, posterior view; B,C, pleotelson; D, uropod; E, pleopod I; F, pleopod II endopod and appendix masculina. Scale bar 0.5 mm.

Temnocephala (Platyhelminthes Turbellaria Rhabdocoela) are common on *Phreatoicopsis* Spencer & Hall, 1897 species, typically on the sternites of the pereon (Wilson & Keable, in press). Cuticular hair of *Peludo paraliotus* n.gen., n.sp. (from sample WA-597) yielded small ostracodes (AM P60541, on slide). Most of these epibionts appear to use the isopods as a substrate, and do not appear to damage the host, at least externally. Because phreatoicideans do not

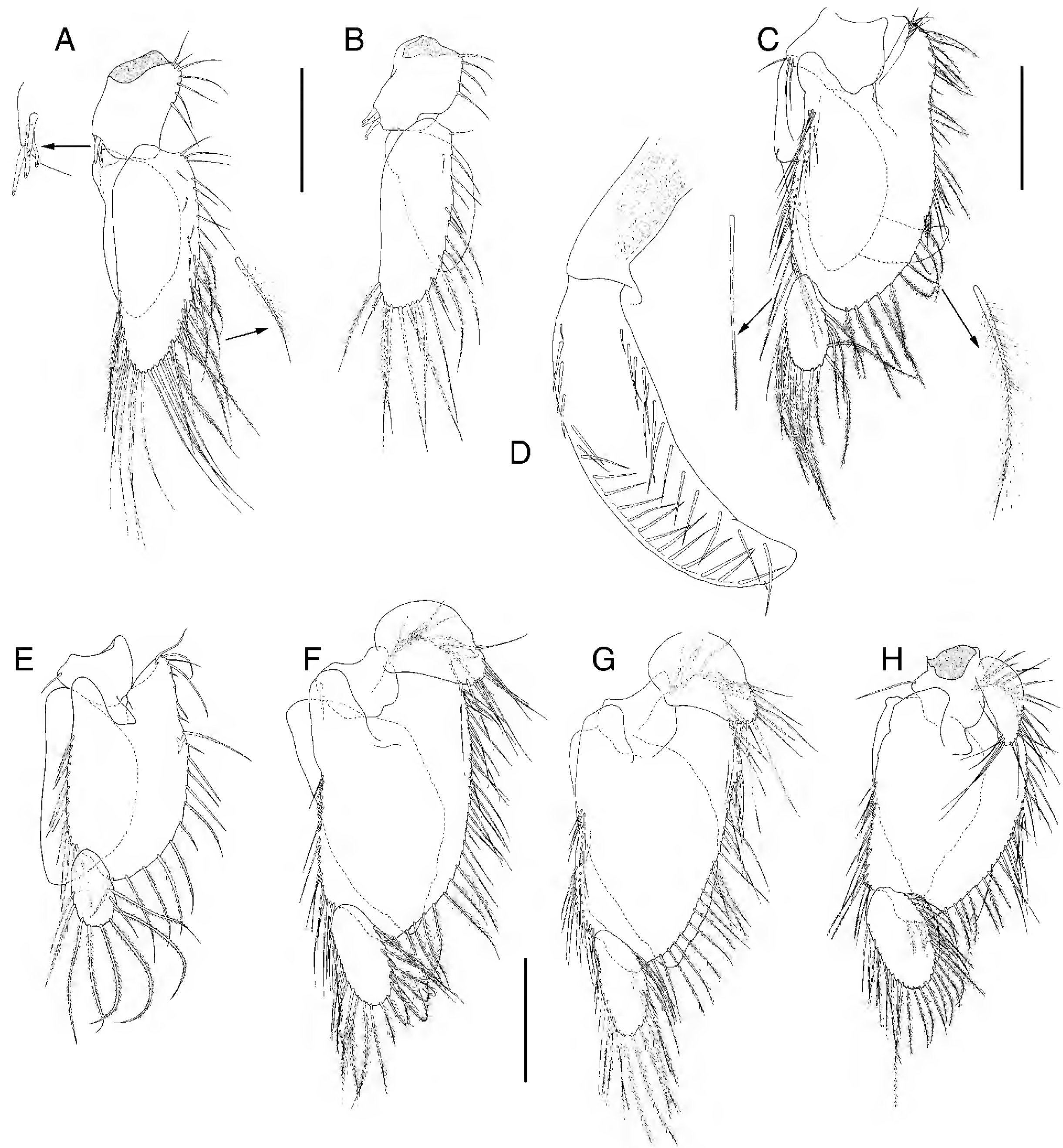

Figure 22. *Platypyga subpetrae* n.gen., n.sp. A,C,D,F–H, paratype ♂ (AM P61459); B,E, paratype ♀ (AM P61458). A,B, pleopod I; C–E, pleopod II; F–H, pleopods III–V. Scale bar 1 mm.

swim well, the sometimes dense infestations of ciliates do not appear to hydrodynamically disadvantage the isopods. The ciliates and the ostracodes attach firmly to the specimens and are not dislodged by our normal SEM preparation procedures.

Conservation. Similar to other recently discovered phreatoicidean taxa from the state of Western Australia (e.g., *Crenisopus* Wilson & Keable, 1999 and *Pilbarophreatoicus* Knott & Halse, 1999), each of the new genera is apparently endemic to a small region of the state. These taxa are therefore vulnerable to extinction, although to varying degrees.

Peludo paraliotus n.gen., n.sp. is restricted to two distinct coastal wetlands in Cape le Grand National Park, east of Esperance. This genus, however, may be more widespread along the south coast than our limited sampling effort suggests. Although our largest collections were made from streams flowing out of the coastal wetlands, we suspect that the main populations occur in the wetlands themselves, and are more insulated from visitation to the Park. Owing to this species occurring in a well-protected national park, it is possibly less vulnerable than the other species.

Platypyga subpetrae n.gen., n.sp. has been found only on the southern facing slopes of the Stirling Range, with at least two distinct localities (below Toolbrunup Peak and below Bluff Knoll). This species occurs in the well-protected Stirling Range National Park, so threats to its continued existence are likely to be low. The type locality is a stream flowing from the scree slope, next to the well-used trail to the summit of Toolbrunup Peak, so it is potentially

vulnerable to increased levels of visitation of the park. The main population of this species, however, may live under the scree slope and therefore could be insulated from any negative impacts.

Eremisopus beei n.gen., n.sp. is the most highly restricted of the three genera: it occurs only in a single stream, "South Creek" flowing west from the Frederick Hills, north of Kalumburu Township in the NW Kimberley region. The limited distribution of this species and its unprotected location makes it extremely vulnerable to any changes that affecting this spring-fed creek. The protection and continued existence of this species requires immediate consideration by the relevant authorities in the state.

Diversity and biogeography in Western Australia. Western Australia now has eight distinctive genera, a surprising level of phreatoicidean diversity considering its overall aridity. These taxa include: *Amphisopus* Nicholls, 1926; *Eremisopus* n.gen.; *Paramphisopus* Nicholls, 1943; *Peludo* n.gen., *Platypyga* n.gen. in the Amphisopodidae; and *Pilbarophreatoicus* Knott & Halse, 1999; *Hyperoedesipus* Nicholls & Milner, 1923 in the Hypsimetopodidae and *Crenisopus* Wilson & Keable, 1999; (see Wilson & Keable, 2001 for discussion of the classification). Based on our recent collections (unpublished data), much undescribed species-level diversity may be present in the genera *Amphisopus* and *Paramphisopus*. *Pilbarophreatoicus* also may include at least two additional undescribed species. This generic diversity is equivalent to that of Tasmania, a much wetter state. Western Australia has a huge area compared to Tasmania, and has many unexplored relict aquifers (Humphreys, 2001) where unique taxa could still be found. We predict that additional taxa of phreatoicideans will be found in this state as permanent groundwaters become better known.

The Western Australian phreatoicidean fauna is also phylogenetically distinct, with taxa in two of the three major clades of phreatoicideans present. No Phreatoicidae are known to occur in Western Australia while Amphisopodidae and Hypsimetopodidae also occur in southeastern Australia. Basal phreatoicideans appear to have been established in Western Australia prior to the diversification of the phylogenetically more derived Phreatoicidae, which are common in southeastern Australia, Tasmania and New Zealand (South Island) (Wilson & Keable, 2001). Interestingly, no Amphisopodidae or Hypsimetopodidae are known from New Zealand, and no Amphisopodidae occur in Tasmania. The explanations for this pattern are undoubtedly historical, and may related to separate centres of diversification within East and West Gondwana during the early Mesozoic. The pattern suggests that the Amphisopodidae and Hypsimetopodidae (Africa, India, western and northern Australia—no data from South America) evolved in East Gondwana, while the Phreatoicidae (SE Australia, Tasmania, New Zealand) evolved in West Gondwana. The zone of overlap and post-Mesozoic mixing between these two faunas, therefore, would include SE Australia and Tasmania. A cladistic test of these hypotheses using many different taxa should address these hypotheses.

ACKNOWLEDGMENTS. This research was generously supported by the Australian Biological Resources Survey and the Australian Museum Centre for Evolutionary Research. Cameron Bee, on the advice of Martyn Robinson, brought *Eremisopus* to our attention, and gave us the initial collection of specimens used in this paper. Anna Cerra and Francis Chee captured hundreds of SEM images, some of which were used in this paper. Our field trips to Western Australia were successful owing to the participation of Tristan Wilson, Kathy Fries-Wilson, Regina Wetzer and Winston Ponder. Staff of the Western Australia Department of Conservation and Land Management provided advice and assistance for our field trips. Di Jones and Melissa Hewitt (Western Australian Museum) kindly assisted with loans of various phreatoicideans and registered our new taxa. Kathy Fries-Wilson suggested the name "*Peludo*" for the "furry" isopods from Cape le Grand. Useful improvements to the manuscript were suggested by Dan Bickel, Gary Poore and an anonymous referee. This paper is a contribution of the Australian Museum Centre for Evolutionary Research. We gratefully thank all these individuals and institutions for their contributions to this research.

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Manuscript received 20 October 2000, revised 3 April 2001 and accepted 9 April 2001.

Associate Editor: Daniel J. Bickel.

Records of the Australian Museum (2002) Vol. 54: 71–98. ISSN 0067-1975

Armadillidae (Crustacea: Isopoda) from Lord Howe Island: New Taxa and Biogeography

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ABSTRACT. Lord Howe Island and associated island, Ball's Pyramid, in the Tasman Sea between Australia and New Zealand, have a surprising diversity of terrestrial isopods. New species in the genera *Pyrgoniscus, Cubaris* and a new genus (*Stigmops*, n.gen.) of the family Armadillidae are described from Australian Museum collections made on Lord Howe Island. Two species, formerly placed in *Anchicubaris*, are moved to the new genus. *Anchicubaris* is revised to show how it differs from the new genus. With these changes, species of *Anchicubaris* no longer occur on Lord Howe Island. A lectotype for *Anchicubaris fongosiensis* is assigned. The homonymy of *Cubaris granulatus* Lewis, 1998b is resolved with a new name and a type species for the genus *Sphenodillo* Lewis, 1998b is assigned. A key to Lord Howe Armadillidae is provided. The biogeography of Armadillidae genera on Lord Howe Island shows possible links to neighbouring regions of New Caledonia and eastern Australia. Because relationships of species in the large genera *Cubaris* and *Pyrgoniscus* are unknown, precise area relationships cannot be estimated. The high diversity and presence of armadillids on the nearby rock, Balls Pyramid, suggests that the Lord Howe fauna is a contracted remnant of a much larger Pleistocene fauna, when lowered sea levels provided interconnections and much larger areas.

LILLEMETS, BIRGITTA, AND GEORGE D.F. WILSON, 2002. Armadillidae (Crustacea: Isopoda) from Lord Howe Island: new taxa and biogeography. *Records of the Australian Museum* 54(1): 71–98.

Lord Howe Island is a small, subtropical island situated on the Lord Howe Rise in the Tasman Sea approximately 700 km northeast of Sydney (31°33'S 159°05'E, Fig. 1). The island covers an area of approximately 15 km^2 and is the eroded remnant of volcanic activity 6–7 million years ago. The main island is dominated by two peaks, Mount Gower (875 m) and Mount Lidgebird (777 m) in the south, hills in the north (up to 200 m high) and lowlands in the middle of the island (Hutton, 1986).

The Lord Howe Rise, upon which the island sits, was separated first from New Zealand and later from Australia approximately 80 million years ago (Hutton, 1986). The Rise has been subject to several sea level changes during which exposed islands have acted as permanent refuges for indigenous organisms or as "stepping stones" for organisms from other landmasses (Clark & Pickard, 1977). The flora and fauna have close relatives in Australia, New Zealand, New Caledonia and Norfolk Island, but its long-term isolation has resulted in a high proportion of endemic species. These species were largely undisturbed until the first recorded human contact in 1788 when Europeans landed on the island. A permanent settlement was founded in 1834 (Hutton, 1986).

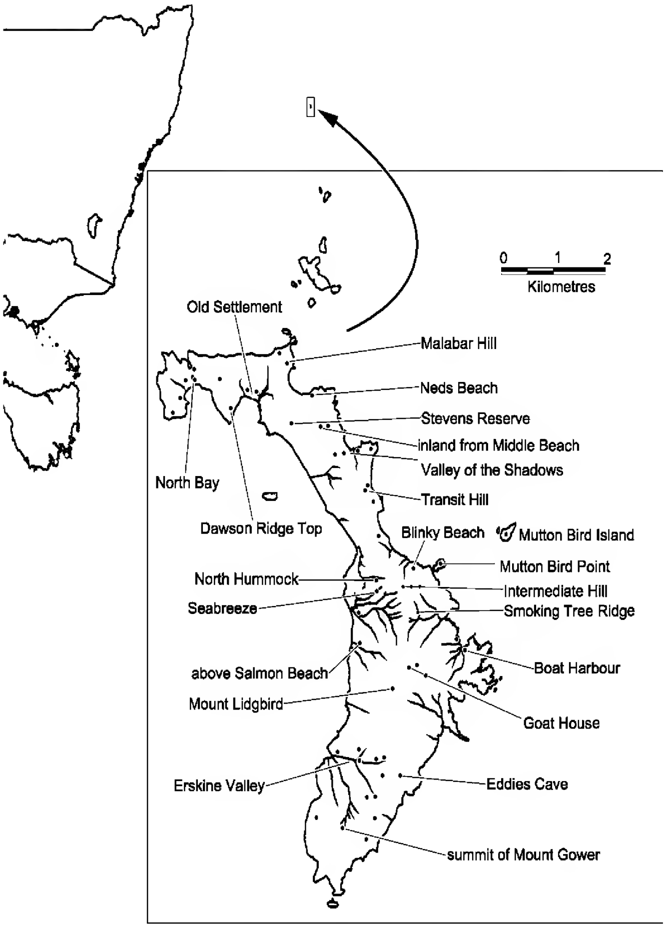

Figure 1. Map of Armadillidae localities on Lord Howe Island based on data from the Australian Museum invertebrate collection. Not all locality names appear in Table 1.

Ball's Pyramid is a much smaller island 25 km southeast of Lord Howe Island that consists of a 550m high steep rock (Sutherland & Ritchie, 1977). It is part of the Lord Howe Island group and connected to the main island by an underwater ridge. Some endemic species that are extinct or are close to extinction on the main island, still persist on Ball's Pyramid. For example, the only two reptiles (a skink, *Leiolopisma lichenigera*, and a gecko, *Phyllodactylus guentheri*) native to the Lord Howe group (Hutton, 1986) are found on Ball's Pyramid.

Three species of Armadillidae have been reported from Lord Howe Island by Vandel (1973) and a further 16 by Lewis (1998b). These species were placed in seven different genera: *Australiodillo* Verhoeff, 1926, *Cubaris* Brandt, 1833, *Anchicubaris* Collinge, 1920, *Orthodillo* Vandel, 1973, *Pseudodiploexochus* Arcangeli, 1934, *Pyrgoniscus* Kinahan, 1859 and *Sphenodillo* Lewis, 1998b. The only published records of non-armadillid terrestrial isopods from Lord Howe Island are *Tasmanoniscus evansi* Vandel, 1973 (Oniscidae), *Trichorhina* sp. Lewis, 1998b (Platyarthridae) and *Ligia australiensis* Dana, 1853 (Ligiidae). Two cosmopolitan species of the family Porcellionidae are also recorded: *Porcellio laevis* Latreille, 1804 and *Porcellionides pruinosus* (Brandt, 1833). These latter two species have been introduced to the island, presumably from Europe.

Despite this previous taxonomic research, terrestrial isopods from Lord Howe Island held in the collections of the Australian Museum include at least 38 different species belonging to the families Actaeciidae, Armadillidae, Philosciidae, Styloniscidae, Oniscidae and Ligiidae (BL, unpubl. observations). This apparent diversity is surprising, given the isolation and small size of the islands. Island biogeography theory (MacArthur & Wilson, 1967) predicts that isolated islands, particularly young ones like Lord Howe Island, should have depressed diversity compared to the mainland regions. The observed high diversity may be a remnant from a much larger area occurring from low sea levels of previous glacial cycles. Alternatively, this level of armadillid diversity might be typical for islands, but only been brought to light by detailed surveys that have been much more extensive than on mainland Australia. If this is the case, then Australian oniscidean diversity may be enormous, requiring detailed assessments of the continental regions.

Oniscidea, the terrestrial isopods, is a monophyletic group based on the reduced triarticulate antennule and the terrestrial adaptations of the pleopods (Schmalfuss, 1989; Tabacaru & Danielopol, 1996; Erhard, 1998). Within the Oniscidea, the Armadillidae is a large family with 78 described genera and approximately 700 species. Selected genera or taxa from geographical areas have been revised, but a comprehensive revision of the entire family has not been done. The taxonomy of the family is therefore confused and in need of a global revision. Nevertheless, the Armadillidae is considered to be monophyletic owing to the dorsal insertion of the uropodal exopod, and perhaps the presence of a bilobed lamellar process on the seventh male pereonite sternite (yet to be confirmed in many species) (Taiti *et al*., 1998).

In this paper, we describe four new species from the armadillid genera *Stigmops*, n.gen., *Pyrgoniscus* and *Cubaris* from the Australian Museum collection. Two species, formerly placed in *Anchicubaris*, are moved into the new genus. We diagnose the new genus and revise *Anchicubaris*, including assigning a lectotype for *Anchicubaris fongosiensis*. The homonymy of *Cubaris granulatus* Lewis, 1998b is resolved and a type species for the genus *Sphenodillo* Lewis, 1998b is assigned. A revised key includes all Lord Howe Armadillidae. Biogeography of the Armadillidae on Lord Howe Island is also discussed.

Materials and methods

Specimens used in this study came from two faunal surveys of Lord Howe Island: T. Kingston and B. Miller (abbreviated K&M) for the Australian Museum "Woodhen Project" in 1978–79 and by G. B. Monteith (abbreviated GBM) as part of a Queensland Museum berlesate study in 1978–80. Table 1 provides the locality data for sample numbers used in the descriptions. Position coordinates of samples were found to have a systematic error owing to the use of an outdated chart; all positions were corrected using a recent digital map of Lord Howe Island. In some cases, no sample numbers were assigned in the original survey, so the sample may be found in Table 1 by referring to the sample date. Photos of live specimens of *Stigmops polyvelota* n.gen., n.sp. and *Stigmops odontotergina* n.sp. were taken by Kingston and Miller. Because specimens of the other species have been preserved in ethanol, live colours cannot be determined.

Table 1. Lord Howe Island localities of terrestrial isopods in the Australian Museum collection. Vegetation type abbreviations: Ct (*Cryptocarya triplinervis*), Cf (*Cleistocalyx fullageri*), Da (*Drypetes australascia*), Hb (*Howea belmoreana*), Hf (*Howea foresterana*), Lf (*Leptospermum flavescens*), Lq (*Linociera quadristaminea*).

place name	latitude longitude	Woodhen Site vegetation type	station number	date collected	collector(s)
Dawson Ridge Top	31°31.3'S 159°03.3'E	Rainforest	no stn. no.	05.xi.1979	GBM
Inland from Middle Beach	31°31.5'S 159°04.4'E	Hf	QMB127	06.xi.1979	GBM
Seabreeze	31°33.0'S 159°05.0'E		no stn. no.	12.ii.1979	K&M
Smoking Tree Ridge, east face	31°33.2'S 159°05.5'E	Cf, Lq (rainforest)	QMB 163	23.xi.1979	GBM
Boat Harbour	31°33.6'S 159°06.1'E	Cf, Lq (rainforest)	QMB 161	23.xi.1979	GBM
Eddies Cave on Gower Track, NE of summit	31°34.8'S 159°05.3'E		QMB 146	16.xi.1979	GBM
southern shoreline of Blinky Beach	31°32.7'S 159°05.5'E	Da, Ct, Hb	QMB 142	12.xi.1979	GBM
Old Settlement	31°31.2'S 159°03.6'E	9; Da, Ct	LHI517	2.iv.1979	K&M
			LHI544	18.iv.1979	K&M
			no stn. no.	5.xi.1979	GBM
Transit Hill (Clear Place)	31°31.5'S 159°05'E	1; Da, Ct, Hf	LHI126	19.ix.1978	K&M
			LHI139	22.ix.1978	K&M
			QMB157	xi.1979	GBM
North Bay	31°31'S 159°03'E	7; Da, Ct, Hf (rainforest)	LHI413–430	15.xi.1978	K&M
			QMB155–156,131	xi.1979	GBM
Stevens Reserve	31°31'S 159°04.5'E	2; Hf forest	LHI196	1.x.1978	K&M
			LHI596	11.vii.1979	K&M
			QMB132,127	xi.1979	GBM
Intermediate Hill	31°32.9'S 159°05.4'E	5; Cf, Lq (rainforest)	QMB123	6.xi.1979	GBM
			QMB142	12.xi.1979	GBM
			QMB163	23.xi.1979	GBM
North Hummock	31°32.9'S 159°05'E	Cf, Lq (rainforest)	QMB125,142	xi.1979	GBM
Erskine Valley	31°34.5'S 159°05'E	8; Da, Ct (rainforest)	no stn. no.	13.ix.1978	K&M
Little Slope, west side of Mount Gower	31°35.0'S 159°04.5'E	6; Hf forest	LHI351–370	22.xi.1978	K&M
			LHI371–382	22.xi.1978	K&M
			LHI385–392	20.xii.1978	K&M
			LHI178 095	30.ix.1978	K&M
			LHI610,613	11.vii.1979	K&M
Mount Gower	31°35'S 159°05'E	3; gnarled mossy forest, Lf	no stn. nos.	8.vii.1978	K&M
			no stn. nos.	21.i.1979	K&M
			no stn. nos.	28.ii.1979	K&M
			no stn. nos.	29.iii.1979	K&M
			no stn. nos.	26.iv.1979	K&M
			no stn. nos.	9.xii.1979	K&M
Ball's Pyramid	31°46'S 159°16'E	Behind exfoliating rock	no stn. nos.	21.i.1980	K&M
			no stn. nos.	24.i.1980	K&M

Some samples on loan during this study were returned only after the manuscript was finished, and were not compared with the main collection; these are referred to as "Additional material not examined". Sex is given only for specimens that were used for the descriptions.

SEM preparation included cleaning of specimens using ultrasound and gentle brushing, where needed. The dehydration process included at least one hour in each of the following baths: 25%, 50%, 70%, 80%, 90%, 100% ethanol and 100% acetone twice followed by critical point drying using 3 cycles of 3 minutes purging and 5 minutes substitution. Images were saved in a TIF format for later processing.

Light micrographs were taken using a Leica MZ8 dissecting microscope with an attached Pixera PVC100C camera connected to a microcomputer. For calibration, an one mm grid was photographed at all scales used. Images were saved in a TIF format.

All images were modified using Adobe Photoshop (ver. 5). For assembly of the plates, the background of each image was deleted and the image was pasted into a transparent layer over a black background. The greyscale tones of each image were adjusted to standardise their appearance. In some instances, a "sharpen" filter was employed to improve visibility of features. The greyscale figures are SEM images, except where indicated.

All examined specimens are deposited in the Australian Museum (AM), Sydney with accession numbers beginning with "P", except for Natural History Museum, London catalogue numbers (BMNH). Descriptions follow the descriptive style of Wilson (1989), wherein the word "times" or "×" is not repeated for ratios; for example, "the length is 0.88 times the width" is simply reported as "length 0.88 width". Otherwise, terms employed follow Schmalfuss & Ferrara (1983). Dimensions of some types are given as length × width in mm.

Taxonomy

Armadillidae Brandt & Ratzeburg, 1831

Diagnosis modified from Schmalfuss & Ferrara (1983). Cephalon compressed longitudinally, with a wide frontal shield; body able to conglobate; pleotelson with quadrangular distal part; antennal flagellum consisting of two articles; maxillula inner lobe with two robust plumose setae; male pereonite 7 sternite with bilobed lamellar process; pseudotracheae on all pleopodal exopods (only on the first four in *Buddelundia*); uropodal protopod flattened with concave medial margin; uropodal exopod reduced, inserted dorsally near protopod medial margin.

Implicit characters

The following are characters found in all species of Armadillidae treated in this paper and therefore can be implicitly included into the descriptions. We use this list as a device to shorten the descriptions, while still providing comparison with taxa that do not have these features. Figures 6, 9 and 10 illustrate many of the typical limb features present in the Armadillidae treated in this paper.

Frons surface slightly depressed to receive antennae; clypeus lateral processes rounded. *Mandible* incisor process with 4 rounded, simple teeth, smaller and more blunt on right mandible than left; left mandible incisor process with small blunt tooth-like structure at lacinia mobilis base; right mandible lacinia mobilis small with two small blunt teeth; left mandible lacinia mobilis larger, with two sharp ridge-like teeth; molar process with fan-shaped row of long setae along thin, elongate base. *Maxillule* outer lobe medial margin with 4 apical larger robust setae, 6 smaller robust setae below; lateral margin apical half with row of setae decreasing in length towards apex. *Maxilliped* basis rectangular, distolaterally strongly rounded; endite rectangular with three thick apical setae; palp article 1 (ischium) broad, flat with one long, thick apical seta on medial side, one smaller seta on midline; article 2 larger, subtriangular, length 2–2.5 article 1, with one apical group of four setae on medial side, one group of 2–3 setae just below, one group of 2–3 setae on lateral margin; article 3 smaller, elongate and narrow, width approximately 0.25 article 2 width, length 0.67 article 2 length, with apical brush of setae, two lateral fine seta. *Male pleopod 1* endopod elongate with grooved tapering distal half, row of short, thick setae along medial side of dorsal groove. Pleopod 2 exopod “L” shaped with broad proximal portion, distal portion elongate, distal half with ventral, densely setose groove; endopod proximal article small, triangular, distal article thin, narrow, tapering, with groove. Monospiracular covered pleopodal lungs present on all five pleopod exopods. *Uropod* protopod proximal portion not visible dorsally; exopod conical, inserted dorsally, not reaching protopod posterior margin, with apical setae; endopod cylindrical, inserted along protopod proximal inner margin, not reaching pleotelson posterior margin.

Remarks. Many armadillid generic types are poorly documented, causing misidentifications of many species. *Anchicubaris fongosiensis* Collinge, 1920 is one such type species, which led to the misidentification of species on Lord Howe Island as members of this genus. To revise species of Lord Howe Island, we must first revisit this species. We therefore provide a new diagnosis and illustrations of the lectotype of *A. fongosiensis* for comparison with the genus *Stigmops* n.gen.

Anchicubaris Collinge, 1920

Type species. *Anchicubaris fongosiensis* Collinge, 1920, by monotypy.

Restricted composition. *Anchicubaris fongosiensis* Collinge, 1920; *A. annobonensis* Schmalfuss & Ferrara, 1983; *A. scoriformis* Collinge, 1945.

Diagnosis. Tergites dorsally ornamented; conglobation by folding, retaining flange along sides; epimera almost horizontal; frontal lamina raised well above level of vertex, straight and without medial incision; epimera 1 endolobes rectangular drawn out into small tooth posteroproximally, epimera 2 endolobes tooth-like; pleotelson hour-glass shaped, distal part short, posterior margin straight; uropod protopod with narrow rectangular distal part; exopod present.

Remarks. The composition of *Anchicubaris* Collinge, 1920 is modified to clarify the affinities of some Lord Howe Island Armadillidae. Lewis (1998b) placed the Lord Howe Island species *Anchicubaris howensis* Lewis, 1998b and *A. demiclavula* Lewis, 1998b in this African genus based on similarities in the shape and distribution of the dorsal tubercles to *A. annobonensis* Schmalfuss & Ferrara, 1983. The large cephalic lobes of *A. annobonensis* are similar to those of *A. demiclavula* but the arrangement of pereon tubercles in *A. annobonensis* is quite different. *Anchicubaris demiclavula* has 3 pairs of tubercles on pereonite 1 and two pairs on each of pereonite 2–7. Two new species described below, *Stigmops polyvelota* n.gen., n.sp. and *S. odontotergina* n.sp., show striking similarities with *A. howensis* and *A. demiclavula*, especially the unique shape and arrangement of the dorsal tubercles and cuticular pits. Our examination of the generic type, *A. fongosiensis* Collinge, 1920 (figs. 2, 3), demonstrates that these Lord Howe Island taxa do not belong in *Anchicubaris*. The shape and distribution of tubercles in *A. fongosiensis* bear no similarity to the Lord Howe Island taxa. Furthermore, *A. fongosiensis* differs in the following features: the cuticular pits characteristic of the Lord Howe Island taxa are absent, epimera 1 endolobes are rectangular (not narrowly pointed), the uropodal exopod is not visible ventrally and pleopods 3–5 exopods are more narrow and pointed, lacking the tuft of setae present on the distal tip in *Stigmops*. Therefore *A. howensis* and *A. demiclavula* are transferred to *Stigmops* n.gen. As a result of these observations, *Anchicubaris* does not occur on Lord Howe Island, thus removing a presumed biogeographic link between Lord Howe Island and Africa.

Anchicubaris fongosiensis Collinge, 1920

Figs. 2, 3

Anchicubaris fongosiensis Collinge, 1920: 484.

Type material. LECTOTYPE ♂ (ex BMNH 1933.1.25.851–870). PARALECTOTYPES (BMNH 1933.1.25.851–870); 85 ind (BMNH 1919.4.26.504–518), 34 ind.

Type locality. Mt. Fongosi, Zululand, South Africa, E. Jones, 17.vii.1917.

Remarks. We designate a large male specimen (ex BMNH 1933.1.25.851–870) from the large syntypic series as lectotype, with the remaining specimens becoming paralectotypes (BMNH 1933.1.25.851–870, BMNH 1933.1.25.504–518).

Stigmops n.gen.

Type species. *Stigmops polyvelota* n.sp.

Composition. *Stigmops polyvelota* n.gen. n.sp., *S. odontotergina* n.sp., *S. howensis* (Lewis, 1998b) and *S. demiclavula* (Lewis, 1998b).

Diagnosis (with differing *A. howensis* state between parentheses). Dorsal ornamentation distinct: cephalon with 4 (2) projecting lobes, ridge above eyes, pereonite 1 with one midline anterior and two posterior lobes, pereonites 2–7 each with pair of midline lobes, increasing in size posteriorly (pereonite 7 with small pair of midline tubercles); dorsal cuticle with scales and numerous pits (Fig. 7F); body convex with nearly horizontal epimera; conglobation with imperfect folding, leaving flange along sides; frontal lamina raised well above level of vertex, cleft in midline (entire); epimera 1 thin lateral margin, dorsal surface concave, epimera 1 ventral surface with ridge close to tergite junction ending in tooth-like endolobe, epimera 2 endolobe tooth-like, endolobes not visible dorsally; pleotelson sides near parallel or hourglass-shaped, posterior margin straight (indented); uropod exopod visible ventrally through gap between pleotelson and uropod protopod distal part.

Etymology. "*Stigmops*" means "pitted face", based on the Greek words "stigme" (a spot or prick) and "ops" (the face). This feminine name refers to the pits on the head and elsewhere (e.g., Fig. 7F) seen in this genus.

Remarks. As discussed above, several species originally included in *Anchicubaris* Collinge have been transferred to *Stigmops* n.gen. We place four endemic Lord Howe Island species in *Stigmops*: *S. polyvelota* n.sp., *S. odontotergina* n.sp., *S. howensis* (Lewis, 1998b) and *S. demiclavula* (Lewis, 1998b). As discussed above, *Anchicubaris fongosiensis*, although related, lacks synapomorphies that support the monophyly of *Stigmops* species. *Stigmops* species shares some similarities with those in *Pyrgoniscus* Kinahan, 1859, including: tooth-like endolobes, epimera 1 with ventral longitudinal ridge, raised frontal lamina, the mode of conglobation and, in *Stigmops howensis* and *Stigmops demiclavula*, the shape of the pleotelson and uropods. These two genera differ in the shape and arrangement of dorsal tubercles, highly convex body shape and presence of cuticular pits.

Stigmops polyvelota n.sp.

Figs. 4–6

Type material. HOLOTYPE ♂, P59952, 9.0 × 4.9 mm, K&M 28.ii.79. PARATYPES from K&M 26.iv.79: P59953, ♀, 8.9 × 4.5 mm, mouthparts on SEM stub, colour photograph K.1030; P59955, ♂, 3 SEM stubs; P59954, ♀.

Type locality. All specimens collected in pitfall traps on Mount Gower, Lord Howe Island, New South Wales, Australia, 31°35'S 159°05'E, altitude 600–650m, K&M, 28.ii.79 and 26.iv.79.

Diagnosis. *Cephalon* frontal lamina cleft; vertex with row of 4 lobes, not higher than pereonal lobes, middle two higher than lateral two. *Pereon* tergite 1–7 each with pair of broad laterally flattened lobes, lateral length of each near height, tergite 1 with one additional anterior transverse ridge-like lobe. *Pleonites* 3–4 dorsal surface with midline longitudinal tubercle, pleonite 3 tubercle larger than pleonite 4 tubercle. *Pleotelson* sides slightly constricted. *Uropod* protopod length 1.6 width; endopod 2.0 exopod length.

Description. *Colour* uniform brown in alcohol. Original photos show darker uniform brown. *Body* (Fig. 4A–C,E) convex with horizontal epimera. Cuticular pits and scales scattered on entire dorsal surface and frons. *Cephalon* (Fig. 4E) frontal lamina cleft, raised above vertex; vertex narrow with row of 4 lobes, not higher than pereonal lobes, middle two higher than lateral two, ridge above eyes; eyes small with approximately 10 ocelli. *Pereon* (Fig. 4A–D) tergite 1–7 dorsal ornamentation consisting of pair of broad laterally flattened lobes on each tergite increasing in size towards posterior, rest of each tergite with low scattered tubercles, tergite 1 with one additional anterior transverse ridge-like lobe, epimera without tubercles. Epimera 1 narrowly rounded anteriorly, lateral margin simple, posterior margin broadly rounded, dorsal surface concave, ventral surface with longitudinal ridge close to tergite junction extending from anterior margin, ending in tooth-like endolobe anterior to posterior margin; epimera 2 anterior and posterior margins rectangular, anterior margin extending in ventral tooth-like endolobe close to tergite junction; epimera 3–7 anterior margins rectangular, posterior margins grading between rectangular to increasingly rounded, endolobes absent; tergites 1–7 posterior margins slightly curved, tergite 1 length 0.2 pereon length. *Pleon* (Fig. 4D) pleura 3–5 truncated, endolobes absent; pleonites 1–5 posterior margins straight; pleonites 3–4 dorsal surface with midline longitudinal tubercle, pleonite 3 tubercle larger than pleonite 4 tubercle. *Pleotelson* (Fig. 4F,G) sides slightly constricted, distal part narrower than proximal, length 0.75 proximal width; posterior margin slightly rounded; two rounded tubercles near anterior margin, two ridge-like tubercles near posterior margin. *Antenna* (Fig. 4E) short, thick, reaching no further than epimera 1 posterior margin; flagellum length 0.75 article 5 length, flagellar article 2 length 2.0 article 1 length; all segments setose. *Mandibles* (Fig. 6A–E). Right mandible lacinia mobilis basal setose lobe with group of long fine simple setae; left mandible with longer and more simple setae, robust penicils not present. *Maxilliped* (Fig. 6L–K) basis rectangular. *Penes* broadly lanceolate; proximal bilobed lamellar process

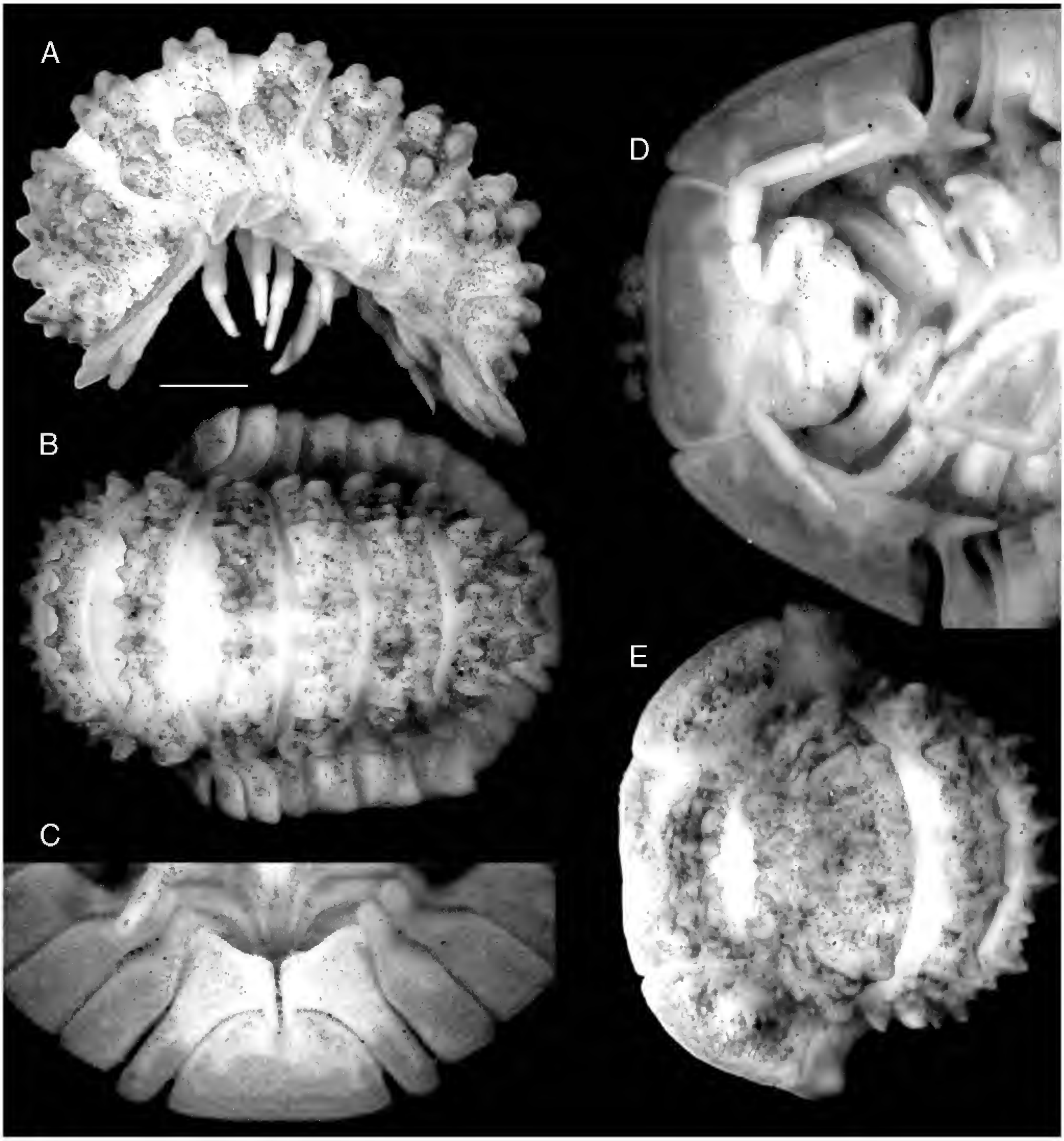

Figure 2. *Anchicubaris fongosiensis* Collinge, 1920, lectotype ♂ (BMNH 1933.1.25.851–870), light micrographs. A, lateral view. B, dorsal view, posterior part of body. C, pleotelson and uropods, ventral view. D,E, head and pereonites 1–2; D, ventral view; E, dorsal view. Scale bar = 1 mm.

subtriangular, small, length 0.25 penes length. *Male pleopod* (Fig. 5A,B) 1 exopod rounded triangular, pseudotrachea along proximal lateral margin, width 0.45 exopod width, length 0.5 exopod length; exopod length 0.4 endopod length. Pleopod 2 exopod proximal wide portion length 0.25 exopod length, length 2.0 exopod width, pseudotrachea along proximal lateral margin, width 0.6 exopod width, length 0.2 exopod length; one lateral long, thick two-segmented seta; endopod proximal article length 0.2 endopod length; exopod length 0.7 endopod length. *Uropod* (Fig. 4F,G) protopod subtriangular, apex rounded, length 1.6 width; length (along inner margin of dorsally visible portion) 1.5 width (at point of exopod insertion); exopod visible ventrally through gap between pleotelson and distal part of protopod, apical setae reach posterior margin of protopod; endopod 2.0 exopod length.

Etymology. *Polyvelota* means "provided with many sails", referring to the broad laterally flattened, dorsal ornamentation of this species.

Remarks. *Stigmops polyvelota* is distinguished from the other species of *Stigmops* by the shape and size of the dorsal

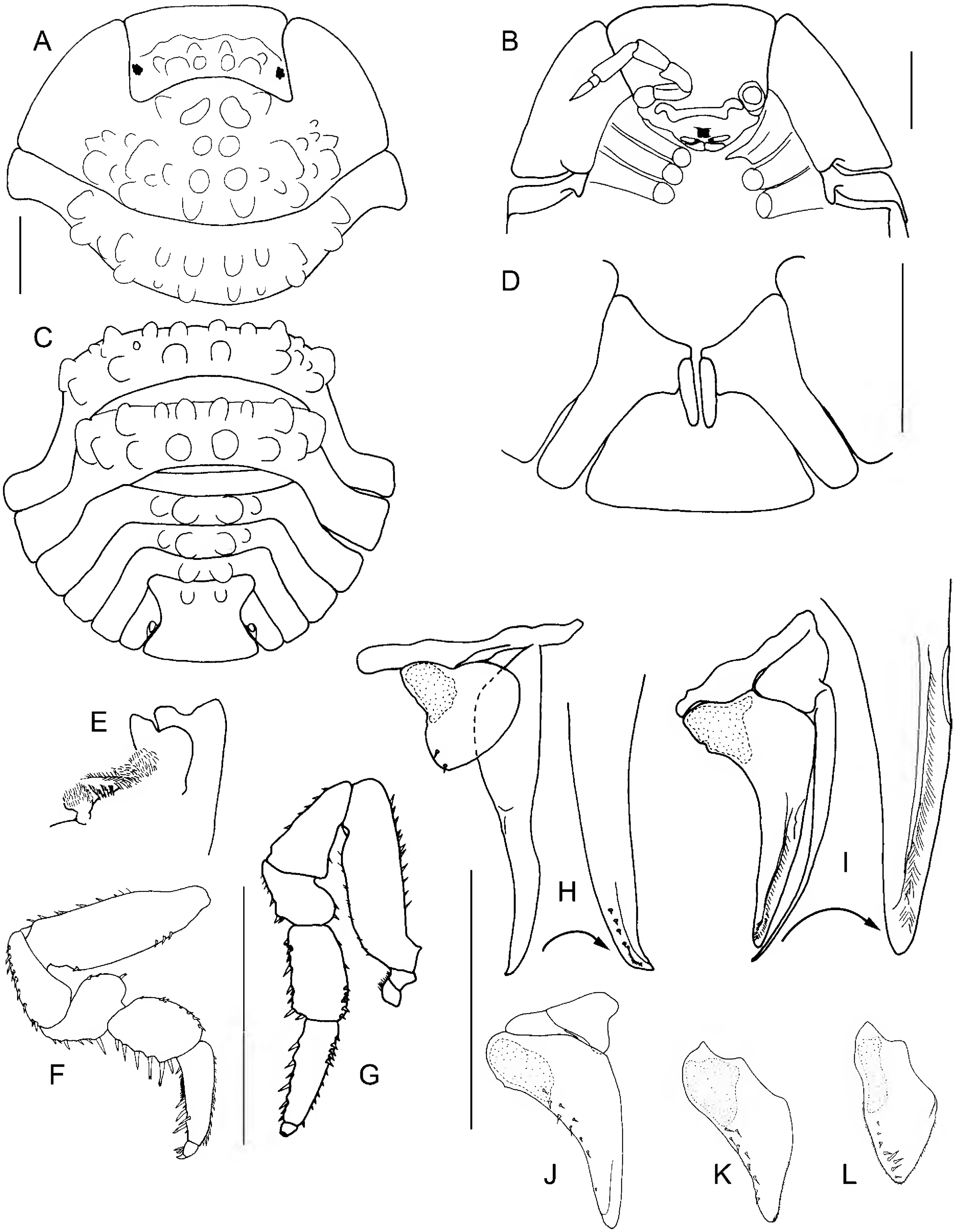

Figure 3. *Anchicubaris fongosiensis* Collinge, 1920. A–D, lectotype ♂ (BMNH 1933.1.25.851–870). A,B, head and pereonites 1–2; A, dorsal view; B, ventral view; C, pleon and pereonites 6–7, dorsal view; D, pleotelson and uropods, ventral view. E–L, paralectotype ♂ (BMNH 1933.1.25.851–870); E, tip of left mandible, ventral view; F, pereopod 1, lateral view; G, pereopod 7, lateral view; H, pleopod 1, ventral view, and tip, dorsal view; I, pleopod 2, and exopod tip, ventral view; J–L, pleopods 3–5, ventral view. Scale bars = 1 mm.

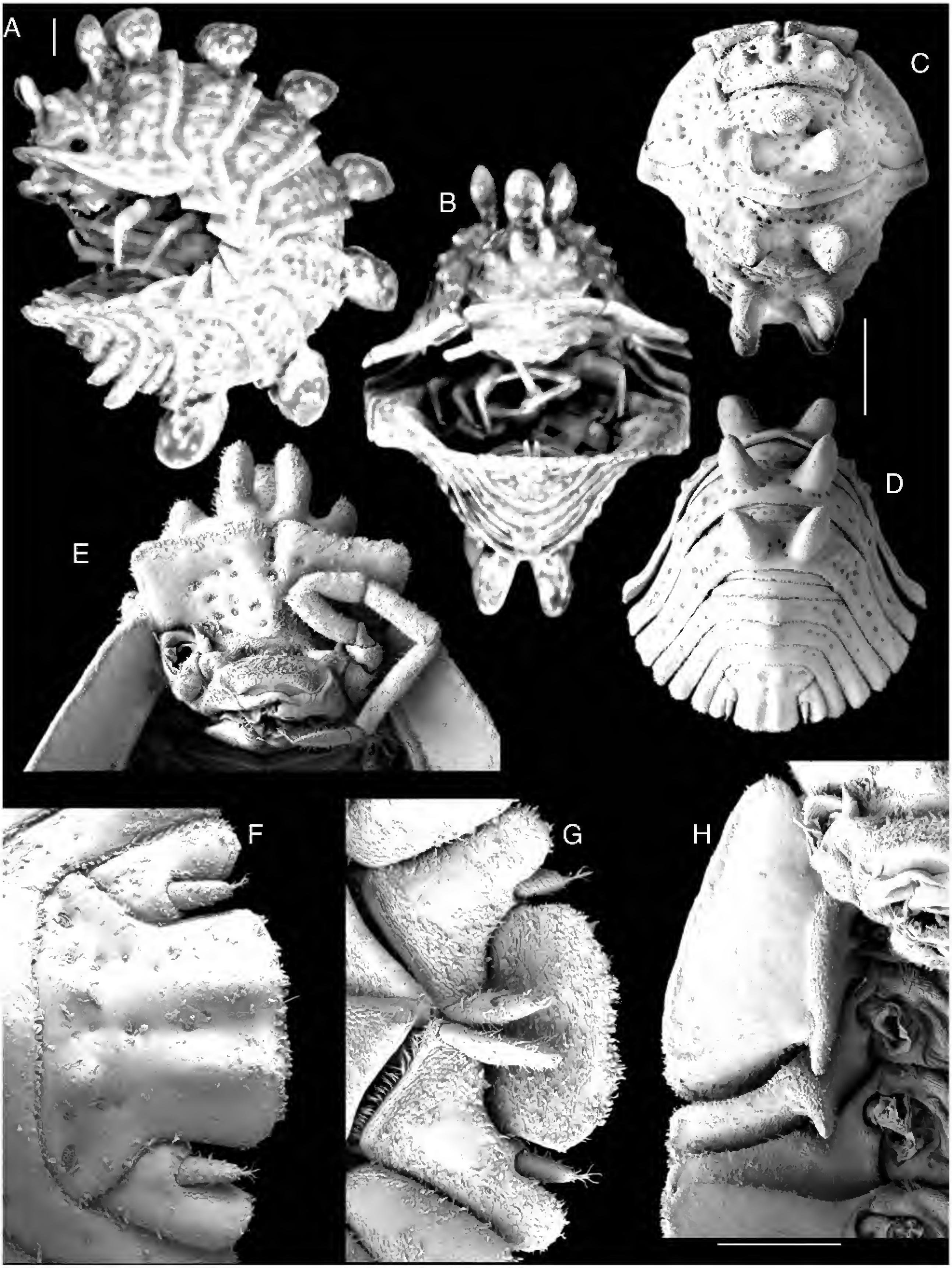

Figure 4. *Stigmops polyvelota* n.gen., n.sp. A,B, holotype ♂ (P59952), light micrographs. A, lateral view; B, ventral view. C–H, paratype ♂ (P59955). C, head and pereonites 1–3, dorsal view; D, pleon and pereonites 5–7, dorsal view; E, head, ventral view; F,G, pleotelson and uropods; F, dorsal view, G, ventral view; H, epimera 1–2 endolobes. Scale bar = 1 mm.

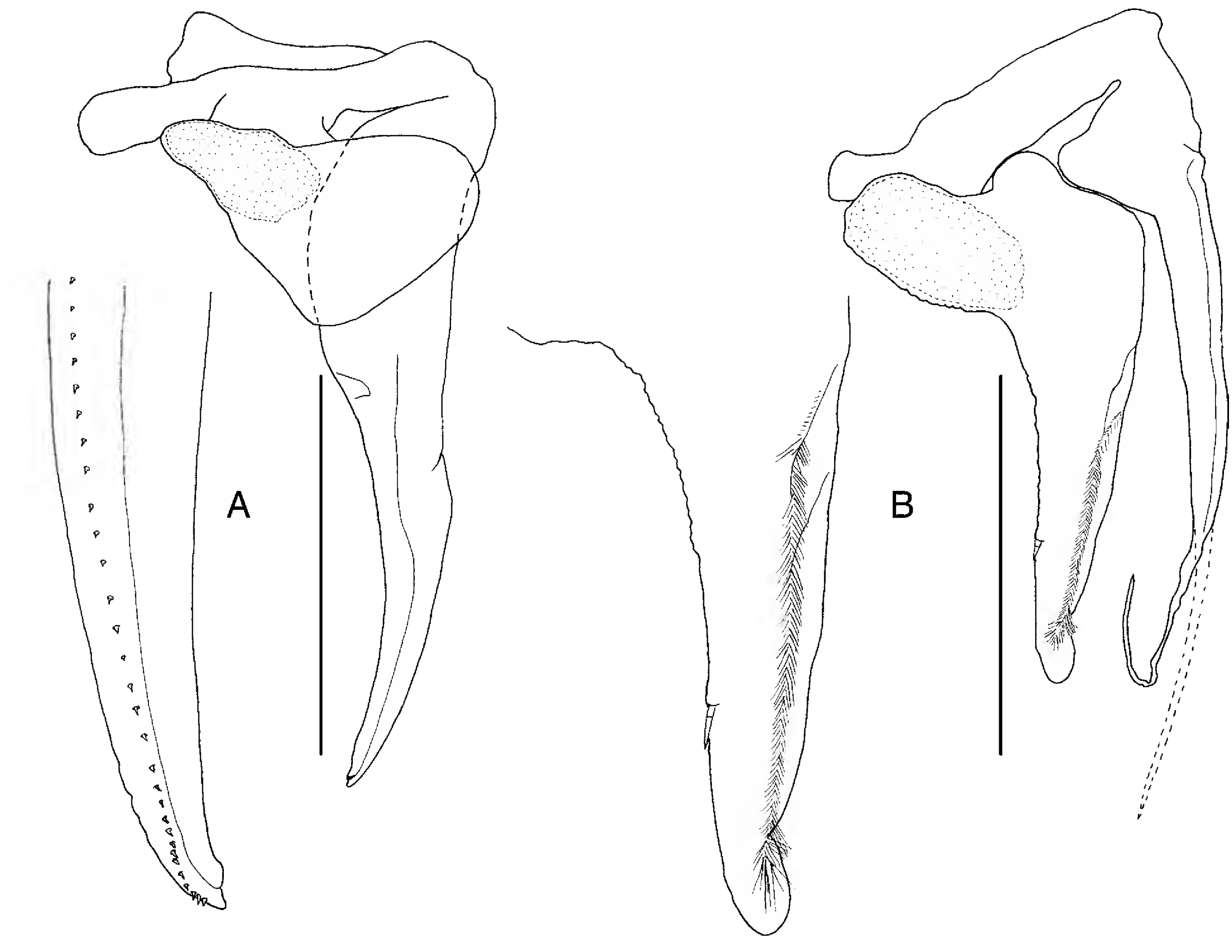

Figure 5. *Stigmops polyvelota* n.gen., n.sp. Paratype ♂ (P59955); A, pleopod 1, ventral view, and tip, dorsal view; B, pleopod 2 and exopod tip, ventral view. Scale bar = 1 mm.

lobes, especially the high cephalic lobes and the stegosaur-like pereonal lobes. This species was rarely encountered in the surveys, suggesting its general rarity in nature.

Stigmops odontotergina n.sp.

Figs. 7–10

Type material. HOLOTYPE ♂, P59976, 4.5 × 2.5 mm, LHI386. PARATYPES: P59980, ♀, 5.4 × 2.9 mm, LHI392; P59996, ♂ on 5 SEM stubs, LHI392; P59981, ♂, 1 SEM stub, LHI392; P59979, ♀, 2 SEM stubs, LHI358; P59994, 15 inds, LHI392; P59995, ♂, SEM stub, LHI178 095; P59977, 2 specimens, LHI 178 095; P59982, 3 specimens, LHI 178 095; P59987, 1 specimen, LHI356; P59988, 2 specimens, LHI357; P59978, 1 specimen, LHI357; P59989, 7 specimens, LHI358; P59990, 2 specimens, LHI365; P59991, 1 specimen, LHI366; P59992, 1 specimen, LHI382; P59993, 3 specimens, LHI386; P59985, 1 specimen, 11.vii.79, LHI610; P59986, 2 specimens, 11.vii.79, LHI613.

Type locality. "Little Slope", west side of Mount Gower, Lord Howe Island, New South Wales, Australia, 31°35'S 159°04.5'E, from pitfall traps in leaf litter, vegetation *Howea forsterana* forest, K&M 22.xi.1978 & 20.xii.1978.

Additional material. P59983, 1 specimen, LHI544; P59984, 1 specimen, LHI544; P34858, 7 inds, LHI 390.

Diagnosis. *Cephalon* frontal lamina indented, midline slightly curved; vertex with four ridge-like tubercles, middle two near longitudinal, lateral two transverse. *Pereon* dorsal ornamentation pereonite 1 with one large anterior longitudinal ridge-like midline tubercle, tergites 1–7 each with one pair of longitudinal, ridge-like midline tubercles near posterior margin, and two pairs of smaller longitudinal ridge-like tubercles lateral to midline. *Pleonites* 2–5 dorsal surface with one midline tubercle each, pleonites 2 and 5 tubercles similar size, pleonite 3 tubercle larger, pleonite 4 tubercle smaller; pleonite 3 with two small lateral tubercles. *Penes* with row of 5 medial ventral spines. *Uropod* protopod length 1.1 width; endopod 2.5 exopod length.

Description. *Colour* uniform light brown in alcohol. Original photos show darker uniform brown. *Body* (Fig. 7A,E,G) strongly convex with subhorizontal epimera. Dorsal cuticle of entire animal and frons with complex pattern of scales and pits. *Cephalon* (Fig. 7B,D) frontal lamina raised off vertex, indented, midline slightly curved, lateral margins triangular. Dorsal ornamentation four ridge-like tubercles, middle two near longitudinal, lateral two transverse along posterior margin, one pair of low round tubercles on midline near anterior margin, ridge above eyes. Head square, width 0.5 pereon width, width 2.0 length. Eyes with 6–10 ocelli in adults. *Pereon* (Fig. 7A–C,E,G) epimera 1 anterior margin narrowly rounded, extending anterior to eye, dorsal surface concave, lateral margin simple, posterior

Figure 6. *Stigmops polyvelota* n.gen., n.sp. A–E, J–L, paratype ♀ (P59953). A–C, right mandible, A,B, ventral view, C, dorsal view; D,E, left mandible, ventral view; J, maxillule; K,L, left maxilliped. F–I, paratype ♂ (P59955); F,G, pereopod 1, F, posterior view, G, dactylus–carpus with antennal cleaning structure, anterior view; H,I, pereopod 7 lateral view. Scale bar = 100 µm.

margin broadly rounded, ventral surface with longitudinal ridge closer to tergite junction than to lateral margin extending from anterior margin, ending in tooth-like endolobe anterior to posterior margin, endolobe not visible dorsally; epimera 2 anterior margin rectangular, posterior margin rounded, ventral surface with large tooth-like endolobe extending posteriorly from anterior margin; epimera 3–7 anterior margin rectangular, increasingly

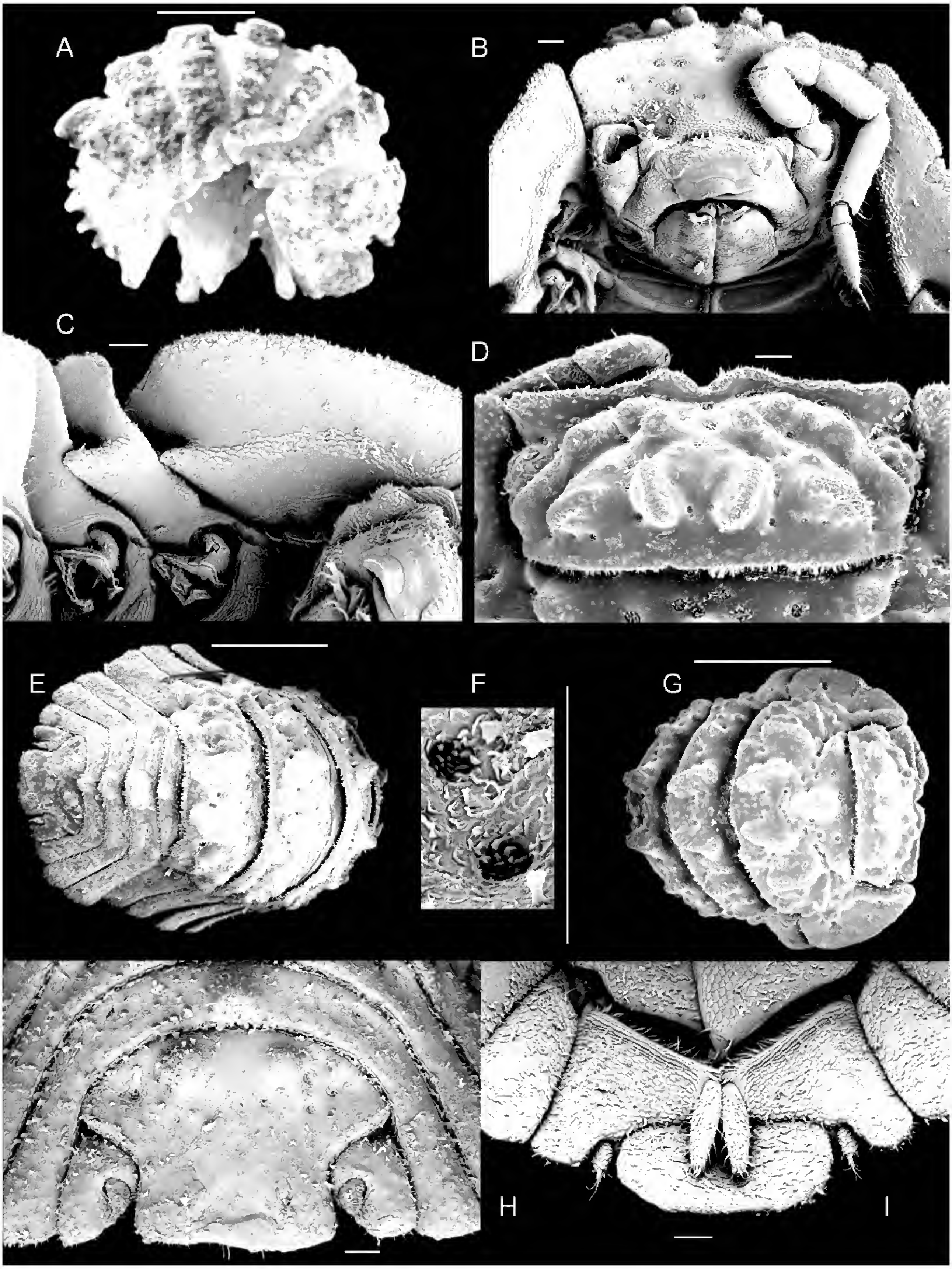

Figure 7. *Stigmops odontotergina* n.sp. A, holotype ♂ (P59976), light micrograph, lateral view. B–D,G, paratype ♂ (P59981); B, head ventral view; C, epimera 1–2 endolobes; D, head, dorsal view; G, head and pereonites 1–3, dorsal view. E,H,I, paratype ♂ (P59995); E, pleon and pereonites 5–7, dorsal view; H,I, pleotelson and uropods, H, dorsal view, I, ventral view. F, paratype ♀ (P59979); enlargement of cuticular pits on pereonite 1. A,E,G, scale bar = 1 mm; B–D,F,H,I scale bar = 100 µm.

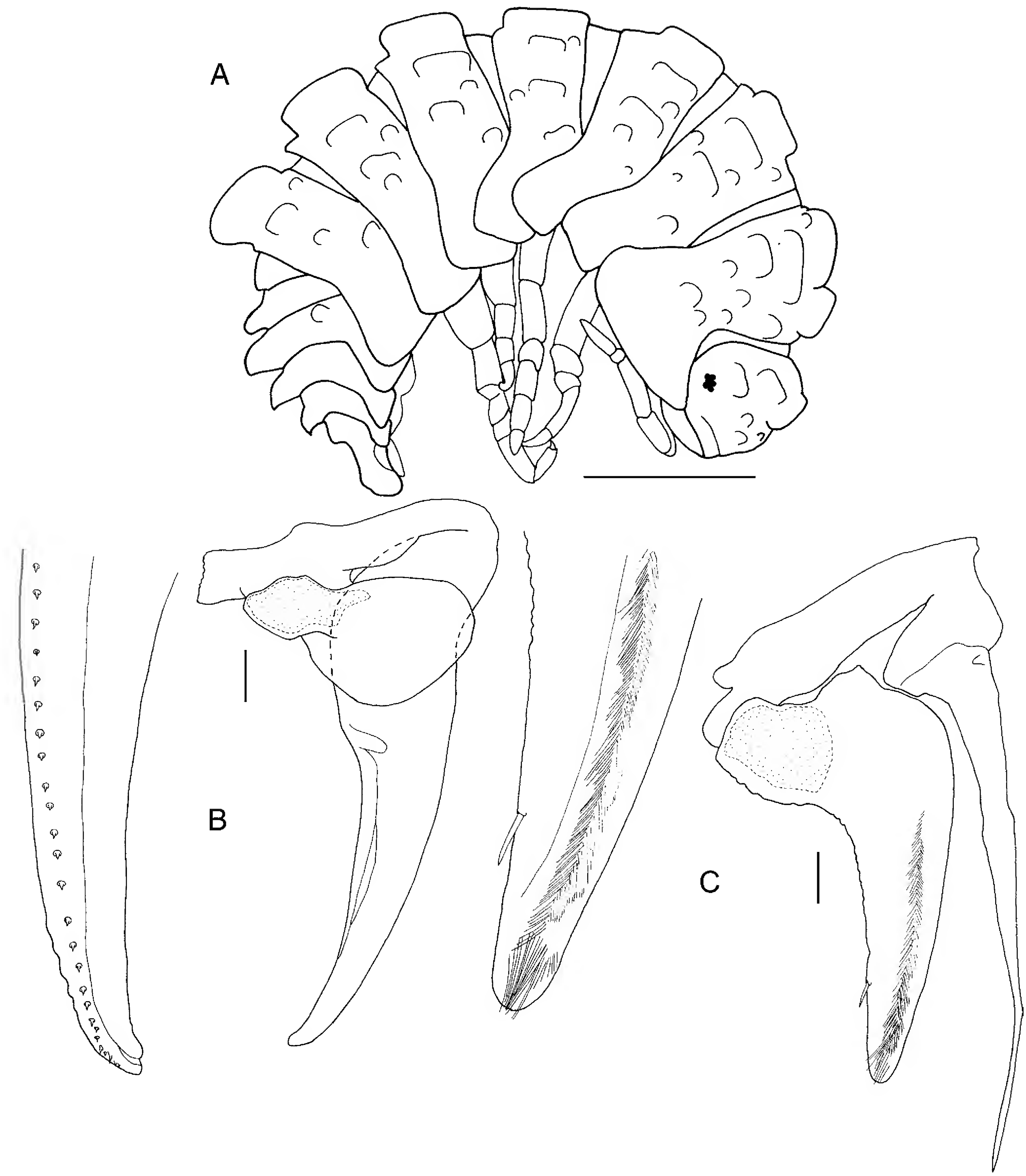

Figure 8. *Stigmops odontotergina* n.sp. A, holotype ♂ (P59976); lateral view. B,C, paratype ♂ (P59978); B, pleopod 1, ventral view, and tip, dorsal view; C, pleopod 2 and exopod tip, ventral view. A, scale bar = 1 mm; B,C, scale bar = 100 µm.

rounded; epimera 3–4 posterior margin rounded, that of epimera 5–7 rectangular; epimera 3–7 endolobes absent; epimera 1–7 decreasingly angled towards posterior. Tergite 1–7 posterior margins slightly curved; tergite 1 length 0.2 pereon length. Dorsal ornamentation pereonite 1 with one large longitudinal ridge-like midline tubercle near anterior margin, one rounded tubercle on each side behind eyes; tergites 1–7 each with one pair of longitudinal, ridge-like midline tubercles near posterior margin increasing in size posteriorly, two pairs of smaller lateral longitudinal ridge-like tubercles, decreasing in size posteriorly; low, rounded tubercles scattered above epimera tergite junction and on epimera. *Pleon* (Fig. 7E) pleura laterally truncate; pleonites 1–5 posterior margins rounded; pleonites 2–5 dorsal surface with one midline tubercle each, pleonites 2 and 5 tubercles similar size, pleonite 3 tubercle larger, pleonite 4 tubercle smaller; pleonite 3 with two small lateral tubercles. *Pleotelson* (Fig. 7H) sides slightly constricted, proximally

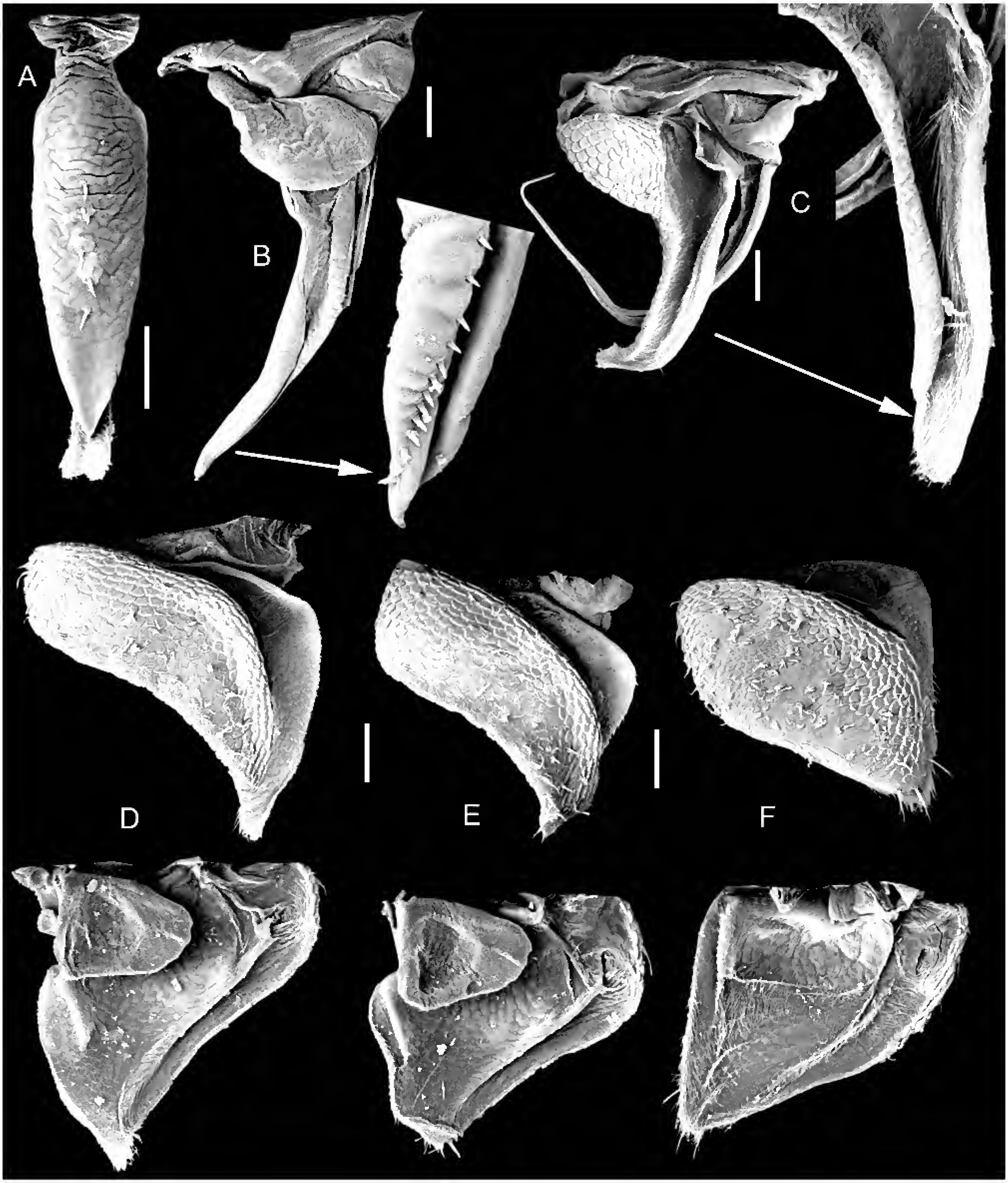

Figure 9. *Stigmops odontotergina* n.sp. Paratype ♂ (P59996); A, penes, ventral view; B, right ♂, pleopod 1 ventral view with enlargement of endopod distal tip, dorsal view; C, right ♂ pleopod 2 with enlargement of exopod distal tip, ventral view; D–F, right ♂ pleopods 3–5, ventral (top) and dorsal (below) view. Scale bar = 100 µm.

wider than distally; length 0.75 width; posterior margin straight; dorsal surface with two proximal and two distal smaller rounded tubercles. *Antenna* (Fig. 7B) short, thick, reaching epimera 1 posterior margin, length 0.85 article 5, flagellar article length proportions 1:3; all segments setose, flagellum more densely including longer apical setae. *Mandibles* (Fig. 10A,B,E,F). Right mandible setose lobe with shorter, thicker, less setae than left mandible, concentrated at lacinia mobilis base; simple setae only, robust penicils not present. *Penes* (Fig. 9A) lanceolate with row of 5 medial ventral spines; proximal bilobed lamellar process rectangular, covering 0.33 penes length. *Male pleopod* (Fig. 8B,C) 1 exopod rounded, pseudotrachea along proximal lateral margin width 0.5 exopod width, length 0.4

Figure 10. *Stigmops odontotergina* n.sp. A–F, paratype ♀ (P59979); A,B, right mandible, ventral view; C,D, left maxilliped, ventral view; E,F, left mandible, ventral view. G–J, paratype ♂ (P59996); G,H, pereopod 1: G, posterior view, H, carpus and propodus with antennal cleaning structure, anterior view; I, pereopod 4, posterior view; J, pereopod 7, posterior view. Scale bar = 100 µm.

exopod length; exopod length 0.25 endopod length. Pleopod 2 exopod proximal wide portion length 0.3 exopod length, exopod width 0.6 exopod length, pseudotrachea along proximal lateral margin width 0.45 exopod width, length 0.2 exopod length, one lateral thick seta 0.25 exopod length from apex; endopod proximal article length 0.2 endopod length; exopod length 0.7 endopod length. Pleopods 3–5 exopods triangular with fine apical setae, ventral scales, dorsal ridge along lateral margin, ventral ridge along proximal margin, pleopod 5 exopod with three long apical setae and many short, fine setae along apex and medial margin. *Uropod* (Fig. 7H) protopod subtriangular; length 1.1 width; median margin straight portion length 0.35 lateral margin length; dorsally visible distal portion short with rounded apex; length (along inner margin of dorsally visible portion) equal to width (at point of exopod insertion); protopod dorsally visible portion length 2.5 exopod length; endopod 2.5 exopod length.

Etymology. *Odontotergina* means "having a toothy back."

Remarks. *Stigmops odontotergina* n.sp. is distinguished from the other species in *Stigmops* by the lower ridge-like

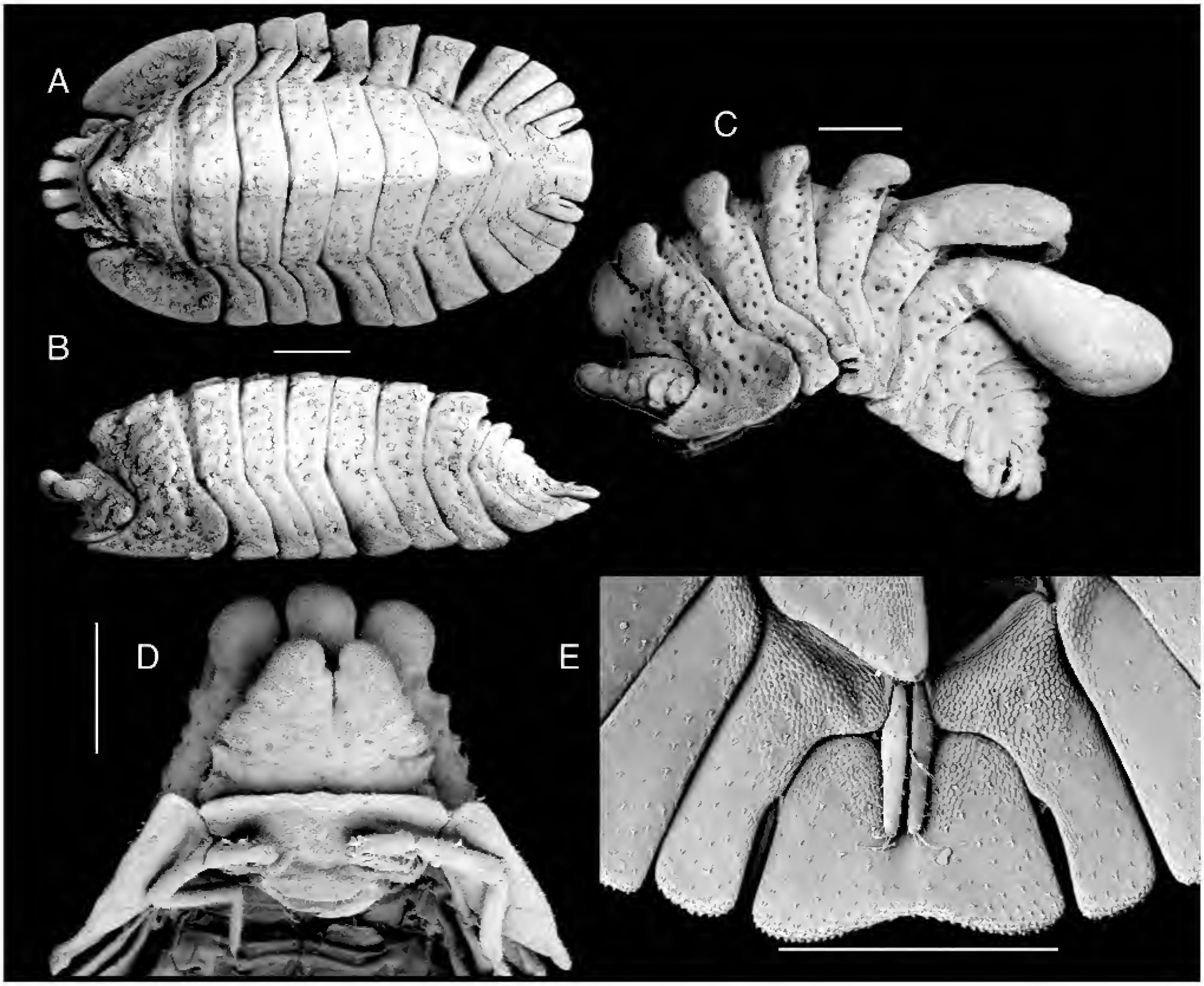

Figure 11. A,B, *Stigmops demiclavula* (Lewis, 1998b). A,B, holotype ♀ (P50141); dorsal and lateral views. C,D, *Stigmops howensis* (Lewis, 1998b) (P60001); C, lateral view; D, head anterior view. E, ♂ (P60000); pleotelson and uropods, ventral view. Scale bar = 1 mm.

cephalic tubercles, rather than large cephalic lobes, and an indented frontal lamina. This species was recorded moderately frequently on Mt. Gower, the type locality.

Stigmops demiclavula (Lewis, 1998b) n.comb.

Fig. 11A,B

Anchicubaris demiclavula Lewis, 1998b: 751–752, fig. 4D–F.

Type material. HOLOTYPE ♀, P50141, on SEM stub, Stevens Reserve, Lord Howe Island, New South Wales, Australia, 31°31.5'S 159°04.5'E, clinging to under side of stone, F. Lewis,v1992.

Additional material: P57350, 5 ♀♀, QMB 142.

Remarks. *Stigmops demiclavula* (Lewis, 1998b) n.comb. is distinguished from the other species in *Stigmops* n.gen. by having four cephalic lobes much higher than the low pereonal tubercles.

Stigmops howensis (Lewis, 1998b) n.comb.

Fig. 11C–E

Anchicubaris howensis Lewis, 1998b:748–51, figs. 4A–C, 5A–F.

Type material. HOLOTYPE ♂, P41900. PARATYPE ♀, P41901.

Type locality. Intermediate Hill, Lord Howe Island, New South Wales, Australia, 31°32.9'S 159°05.5'E, under stone, F. Lewis, 1.v.1992.

Additional material. P53107, 6 ind, Intermediate Hill, 6.xi.1979; P58099, leaf litter, QMB161; P58100, 4 ind, LHI 596; P58101, 1 ind, just below summit of Intermediate Hill, QMB 123; P58102, 64 ind, QMB125; P58103, 1 ind, QMB 127; P58104, 1 ind, QMB 142; P58105, 1 ind, QMB 146; P58106, 1 ind, QMB 163; P58107, Intermediate Hill, leaf litter berlesate, GBM, 06.xi.1979; P58108, 1 ind, Dawson Ridge Top, 05.xi.1979; P58109, P58167, P58169, 10 ind, Mount Gower, pitfall, K&M 08.vii.1978; P58167–P58169, 1 ind each, Mount Gower, K&M 08.vii.1978; P58110, 1 ind, Mount Gower, pitfall, K&M 09.ii.1979; P58111,

P58160, P58161, P58163, P58165, 15 ind, Mount Gower, pitfall, K&M 29.i.1979; P58164, 1 ind, Mount Gower, pitfall, 29.iii.1979; P58166, Mount Gower, pitfall, K&M 28.ii.1979; P58162, 1 ind, Mount Gower, pitfall; P58170, 1 ind, Old Settlement; P58171, 63 ind, Seabreeze, pitfall, K&M 12.ii.1979.

Remarks. *Stigmops howensis* (Lewis, 1998b) n.comb. differs from the other species of *Stigmops* n.gen. by only having two large lobe-like tubercles on the cephalon, with the lateral tubercles reduced to small angular points at the base of the medial tubercles. Additionally, the dorsal pereonite tubercles show an extremely marked decrease in size from pereonite 6 to 7. The frons of this species also lacks cuticular pits that are present in the other species. Additional unusual features include an uncleft frontal lamina, a constricted pleotelson with an indented posterior margin, and long and narrow uropodal protopods. This showy species with its impressive dorsal lobes is frequently encountered in the previous surveys.

Pyrgoniscus Kinahan, 1859

Pyrgoniscus Kinahan, 1859: 134.
Merulana Budde-Lund, 1913.

Type species. *Pyrgoniscus cinctutus* Kinahan, 1859, by monotypy.

Diagnosis. Body dorsoventrally flattened with horizontal epimera; conglobation imperfect owing to folding body, leaving flange along sides; frontal lamina raised well above vertex, with or without midline cleft; epimera 1–2, sometimes 1–3, with tooth-like endolobes close to tergite junction; epimera 2–7 and pleura 3–5 ridged; pleotelson hourglass shaped; uropod protopod distally narrow rectangular, proximal part short; uropod exopod present, well developed.

Remarks. *Pyrgoniscus*, with an uncertain composition, includes 19 species with representatives in Africa, Madagascar and the Australasian region. The above diagnosis is derived from the original diagnosis by Kinahan (1859) and our new observations. *Pyrgoniscus* was created by Kinahan (1859) for the species *P. cinctutus* from "the Eastern Seas". Stebbing (1900) later considered *Pyrgoniscus* a synonym of *Cubaris* Brandt, 1833. Budde-Lund (1904) placed *cinctutus* in his "section X" of *Spherillo* and later renamed the section *Merulana*, a subgenus of *Spherillo* (Budde-Lund, 1913). Verhoeff (1926) elevated *Merulana* to a genus, which was retained by Vandel (1973). Monod (1935) and Ferrara (1977) consider *Merulana* to be a junior synonym of *Pyrgoniscus*. A.J.A. Green (pers. comm. in Lewis, 1998a,b) disagreed that the described Australian species of *Merulana* belong in *Pyrgoniscus*. Our preliminary phylogenetic analysis of some species in these two genera finds *Merulana boydensis* Lewis, 1998a nested within *Pyrgoniscus*, suggesting that the two genera may not be distinct. Ultimately, an examination of the type species for both genera will allow a decision on this uncertainty. Several species currently placed in *Pyrgoniscus* are quite different from the type species, so the monophyly of the genus is uncertain. A comprehensive revision is therefore needed.

Nevertheless, the current species *Pyrgoniscus scopelicus* n.sp. mostly agrees with the original diagnosis of the genus. This new species lacks the medial cleft of the frontal lamina indicated in the original diagnosis. Three other species without a cleft frontal lamina have previously been placed in *Pyrgoniscus, P. lanceolatus* Ferrara, 1977 (Kenya), *P. petiti* Monod, 1935 (Madagascar) and *P. intermedius* Lewis, 1998b (Lord Howe Island). Two separate groups occur within this genus, based on the presence or absence of a cleft frontal lamina. *Pyrgoniscus scopelicus* lacks endolobes on epimera 3, which are present in the original type species. Many species placed in *Pyrgoniscus* also lack endolobes on epimera 3, including *P. petiti* Monod, 1935 (Madagascar), *P. hispida* (Vandel, 1973) (NSW), *P. canaliculatus* (Budde-Lund, 1904) (Chatham Island), *P. intermedius* Lewis, 1998b (Lord Howe Island), *P. bicarinatus* (Budde-Lund, 1913) (NSW, Queensland) and *P. iniquus* (Budde-Lund, 1904) (Queensland).

Seven other species from the Australasian region have been placed in *Pyrgoniscus*: *P. impressifrons* (Budde-Lund, 1904) (NSW); *P. chathamensis* (Budde-Lund, 1885) (Chatham Island); *P. carinatus* (Verhoeff, 1926), *P. noduligerus* (Verhoeff, 1926), *P. translucidus gracilior* (Verhoeff, 1926), *P. translucidus translucidus* (Budde-Lund, 1885) and *P. exilis* (Budde-Lund, 1885) (New Caledonia). *Merulana rugosa* (Budde-Lund, 1913), also from Queensland, has been classified in *Pyrgoniscus* (Monod, 1935; Ferrara, 1977).

Pyrgoniscus scopelicus n.sp.

Figs. 12–14

Type material. HOLOTYPE ♂, P59946, 10.7 × 6.0 mm, Ball's Pyramid K&M 24.i.80. PARATYPES, all from Ball's Pyramid, K&M 21.i.80 or 24.i.80: P59950, 14.2 × 8.6 mm.; P59997, ♂, 5 SEM stubs; P59947, ♂; P59949, ♂; P59998, ♀, 3 SEM stubs, photo K.1037; P59951, 2 ♀♀; P59948, 3 ♀♀.

Type locality. Ball's Pyramid (near Lord Howe Island), New South Wales, Australia, 31°46'S 159°16'E, collected under and behind exfoliating rock, crevice in rock face, K&M, 21& 24 January 1980.

Additional material. P34877, 9 inds; P34878, 27 inds; Ball's Pyramid, collected under and behind exfoliating rock, crevice in rock face, K&M, 24.i.80.

Diagnosis. *Cephalon* frontal lamina entire, straight; ridge-like tubercle above each eye. *Pereonite* 1 dorsal ornamentation with midline tubercles forming a "V" behind anterior margin, area around it smooth, tubercles concentrated in two round "shoulder" areas. *Pleonites* dorsal surface smooth. *Pleotelson* hourglass shape; posterior margin straight; single midline ridge distally from level of constriction, not reaching posterior margin. *Male pereopod* 1 carpus distoventrally with "brush" of setae, increasing in length distally. *Uropod* protopod length 1.9 width; dorsal surface ridged; endopod 3.0 exopod length.

Description. *Colour* uniform grey-brown in alcohol. *Body* (Fig. 12A,B,G) dorsoventrally flattened with expanded horizontal epimera. *Cephalon* (Fig. 12C,D) frontal lamina raised above vertex, uncleft, straight, distal lateral margins triangular; ridge-like tubercle above each eye, row of low,

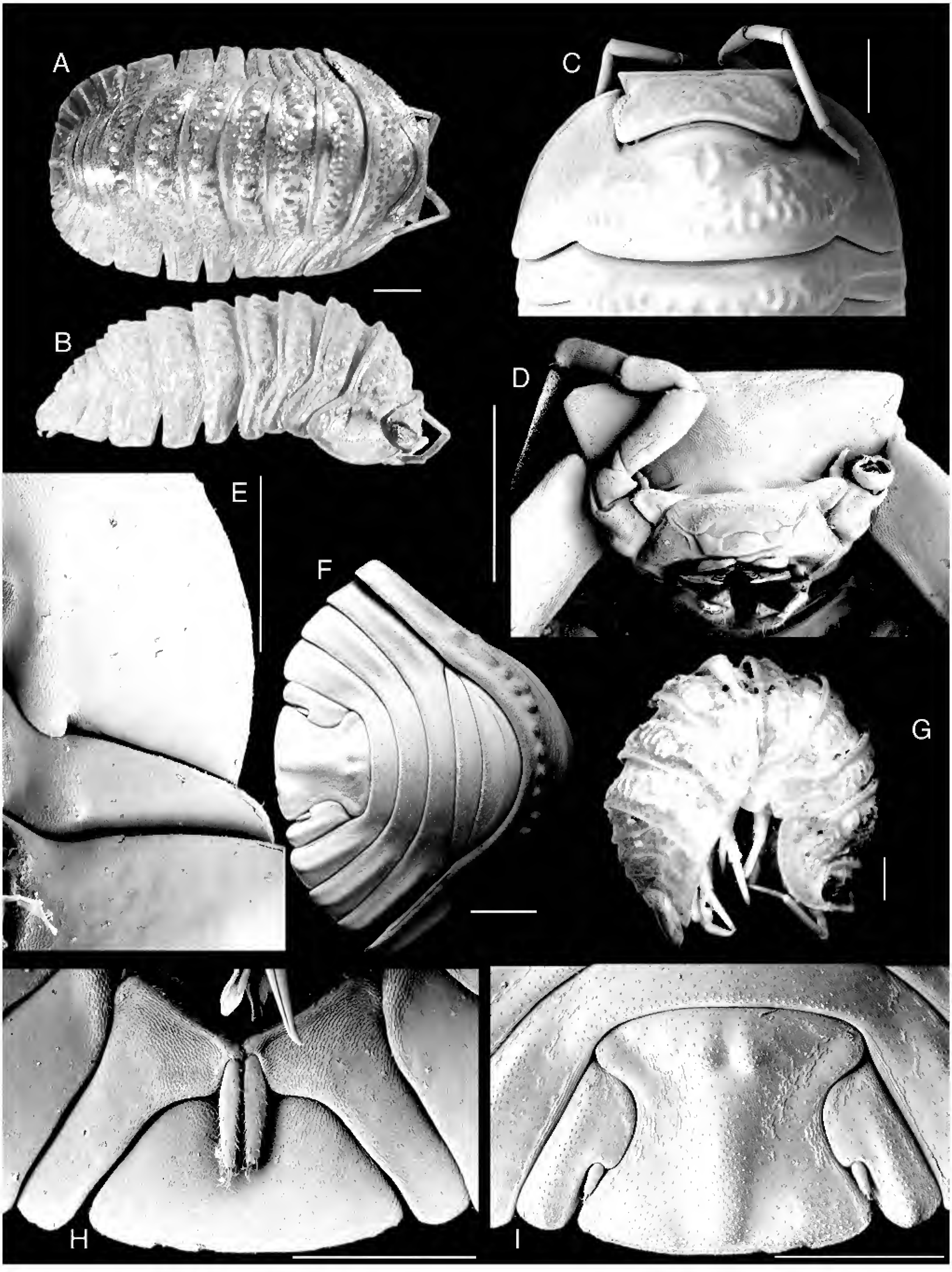

Figure 12. *Pyrgoniscus scopelicus* n.sp. A–C, paratype ♀ (P59998); A,B, light micrographs, A, dorsal view, B, lateral view; C, head and pereonite 1, dorsal view. D–F,H,I, paratype ♂ (P59997); D, head, ventral view; E, epimera 1–2 endolobes; F, pleon and pereonite 7, dorsal view; G, holotype ♂ (P59946), light micrograph, lateral view; H,I, pleotelson and uropods, H, ventral view, I, dorsal view. Scale bar = 1 mm.

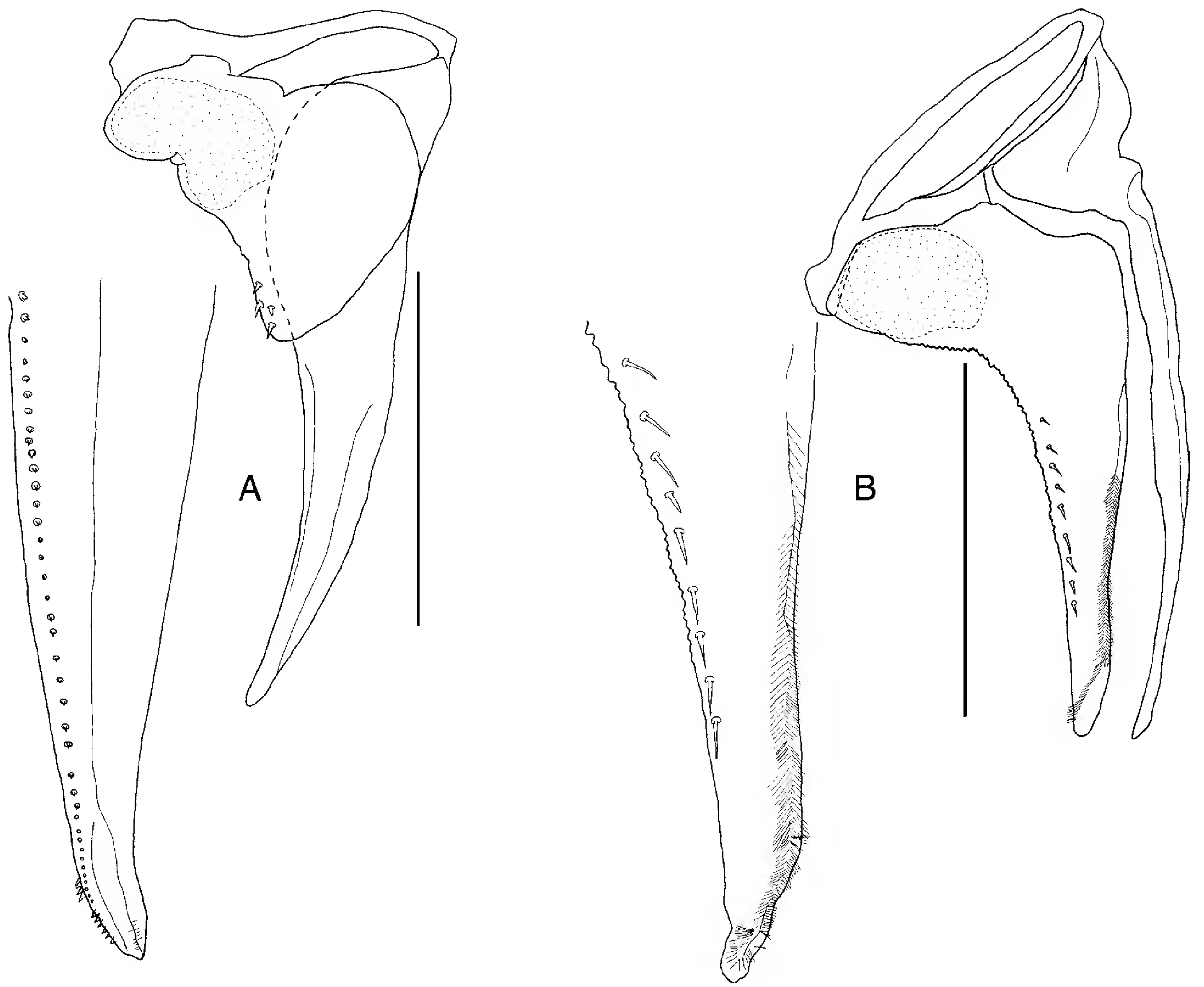

Figure 13. *Pyrgoniscus scopelicus* n.sp. Paratype ♂ (P59949); A, pleopod 1, ventral view, and tip, dorsal view; B, pleopod 2 and exopod tip, ventral view. Scale bar = 1 mm.

rounded tubercles along posterior margin, scattered low rounded tubercles; head width 2.5–3.0 length. Eyes with 17–20 ocelli in adults. *Pereon* (Fig. 12A–C) epimera 1 narrowly rounded anteriorly, lateral margin simple, posterior margin rounded rectangular, dorsal surface concave, ventral surface with longitudinal ridge close to tergite epimera junction extending from anterior margin, ending in tooth-like endolobe anterior to posterior margin; epimera 2 anterior margin rectangular, posterior margin rounded rectangular, ventral surface anterior margin thickened, extending in blunt tooth-like endolobe close to tergite junction near midline; epimera 3–7 anterior margins rectangular, decreasingly angled towards posterior, epimera 7 straight; epimera 2–4 posterior margins rounded, that of epimera 5–7 rectangular; epimera 3–7 endolobes absent. Tergites1–6 posterior margins slightly curved, tergite 7 straight; tergite 1 length 0.25 pereon length. *Dorsal ornamentation* (Fig. 12A–C) tergite 1 midline tubercles forming a "V" behind anterior margin, area around it smooth, tubercles concentrated in two round "shoulder" areas, rest of tergite with scattered tubercles, narrow band along posterior margin smooth; tergite 2–7 each with row of tubercles, smooth narrow band along posterior margin; epimera 1 with scattered tubercles, epimera 2–7 ridged; tergal cuticle with small scattered scales. *Pleon* (Fig. 12F) pleura 3–5 truncate, ridged; pleonite 1–2 posterior margin straight, pleonite 3–5 slightly curved; endolobes absent; pleonites dorsal surface smooth. *Pleotelson* (Fig. 12I) hourglass shape, greater part posterior to constriction, proximal width 0.9 distal width, length 0.9 proximal width; posterior margin straight; two rounded tubercles near anterior margin, midline ridge distally from level of constriction, not reaching posterior margin. *Antenna* (Figs. 12C,D, 14L) long, slender, reaching epimera 2 posterior margin; flagellum length 0.6 article 5 length; flagellar articles length proportions 1:2; all segments setose, flagellum with long apical seta. *Mandibles* (Fig. 14 A,B,D,E). Right mandible lacinia mobilis base setose lobe with row of long simple setae; left mandible with 6 robust penicils. *Maxilliped* (Fig. 14F,G) palp article 2 apical group of setae on small lobe. *Male pereopod* 1 (Fig. 14H,I) carpus distoventrally with "brush" of setae, increasing in length distally. *Penes* (Fig. 14K) lanceolate; proximal bilobed lamellar process triangular, length 0.4 penes length. *Male pleopod* 1 (Fig. 13A,B) exopod triangular, with four separate lateral setae near apex; pseudotrachea along proximal lateral margin, width 0.5 exopod width, length 0.5 exopod length; exopod length 0.35 endopod length. Pleopod 2 exopod length 2.0 width, proximal wide portion length 0.3 exopod length, pseudotrachea along lateral margin, width 0.5

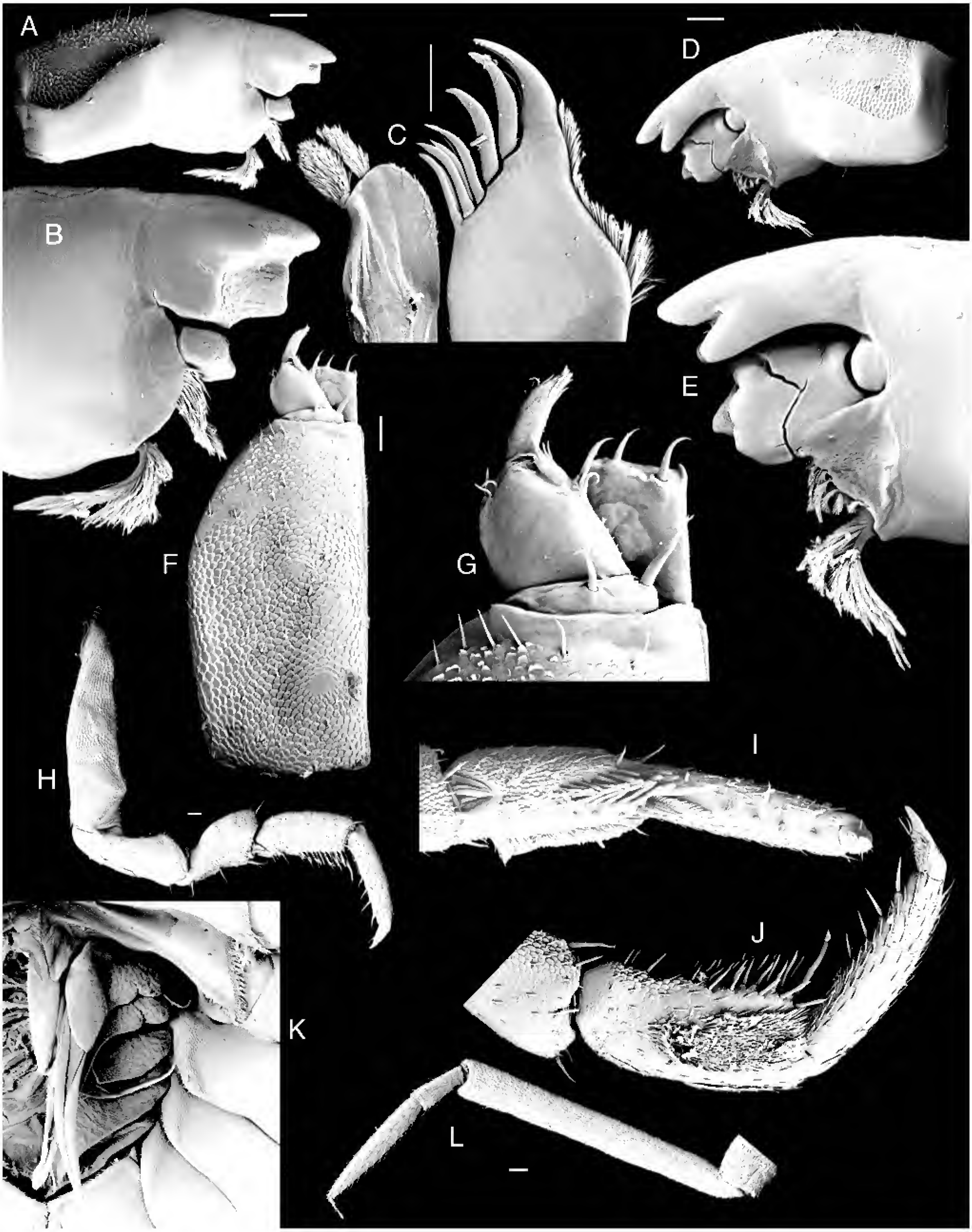

Figure 14. *Pyrgoniscus scopelicus* n.sp. A–G,L, paratype ♀ (P59998); A,B, right mandible, ventral view; C, maxillule, ventral view; D,E, left mandible, ventral view; F,G, right maxilliped, ventral view; L, antenna. H–K, paratype ♂ (P59997); H–J, pereopod 1: H, posterior view; I, carpus-dactylus, ventral view; J, same with antennal cleaning structure, anterior view; K, ♂ pleopods, *in situ*. Scale bar = 100 µm.

exopod width, length 0.2 exopod length, distolateral row of long, thick setae; endopod proximal article length 0.2 endopod length; exopod length 0.75 endopod length. Pleopods 3–5 exopods ridged near dorsolateral margin, ventral long thick setae along lateral margin of apical half. *Uropod* (Fig. 12H,I) protopod length 1.9 width; proximal medial margin straight portion 0.2 protopod length; protopod distally visible dorsally, length 0.67 protopod length; length (along inner margin of dorsally visible portion) 2.0 width (at point of exopod insertion); dorsal surface ridged; exopod inserted dorsally midway to apex, length 0.25 protopod dorsally visible portion length; endopod 3.0 exopod length.

Etymology. *Scopelicus* means "of a rocky crag projecting from the sea", a good description of Ball's Pyramid.

Remarks. We here list all species that have been recorded in Pyrgoniscus and indicate how *P. scopelicus* n.sp. differs from them. The frontal lamina is lower in *P. scopelicus* than in *P. lanceolatus* Ferrara, 1977 and *P. petiti* Monod, 1935. The straight frontal lamina differentiates it from *P. intermedius* Lewis, 1998b (also from Lord Howe Island). Unlike this species, the frontal lamina is cleft in *P. cinctutus* Verhoeff, 1926, *P. exilis* (Budde-Lund, 1885), *P. translucidus translucidus* (Budde-Lund, 1885), *P. hispida* (Vandel, 1973), *P. canaliculatus* (Budde-Lund, 1904), *P. iniquus* (Budde-Lund, 1904), *P. noduligerus* (Verhoeff, 1926), *P. translucidus gracilio* (Verhoeff, 1926), *P. bicarinatus* (Budde-Lund, 1913) and *P. chathamensis* (Budde-Lund, 1885). *Pyrgoniscus carinatus* (Verhoeff, 1926) has a straight sided pleotelson rather than an hourglass shape. A single ridge on the pleotelson separates this species from *P. impressifrons* (Budde-Lund, 1904) by a single ridge on the pleotelson, and from *P. rugosus* (Budde-Lund, 1913) by differences in dorsal ornamentation (see Fig. 12A,B).

Cubaris Brandt

Cubaris Brandt, 1833: 189.
Armadillo, section VI, Budde-Lund, 1904: 118

Type species. *Cubaris murina* Brandt, 1833.

Diagnosis. Frontal lamina not raised above vertex, midline not indented; antennae slender; dorsal surface smooth, rugose or tuberculate, but without spines; epimera tergite junctions 1–6 posterior margins more or less incurved, tergite 7 junction straight or shallowly incurved; epimera 1 posterior margin entire, not cleft; epimera 1 endolobe small, not visible dorsally, not forming continuation of epimera margin; epimera 2 endolobe not projecting beyond epimera margin; tergite 1 length 0.2–0.25 pereon length; pleotelson sides parallel or constricted, dorsal surface not keeled, posterior margin bluntly rounded, straight or shallowly incurved, not deeply incised in midline; pleopods width greater than 0.3 pleon width; proximal portion length less than 0.3 protopod length, inner margin near exopod insertion smoothly concave.

Remarks. *Cubaris* is a large genus comprising over 100 species worldwide, 29 of which have been described from the Australia-South Pacific region. Schmalfuss (1983) considers it to be a "heterogeneous and artificial group defined by symplesiomorphic characters". The group is not monophyletic and is in need of a comprehensive global revision.

The genus was created by Brandt (1833) for the pantropical species *C. murina*. Budde-Lund (1904) redefined the genus as sections of his genus *Spherillo*. Jackson (1935) later identified Verhoeff's (1926) genus *Nesodillo* as a synonym of *Cubaris*, which was retained by Green (1961). Taiti *et al.* (1998) re-established *Nesodillo* as a distinct genus and assigned *N. sarasini* Verhoeff, 1926 as the type species. Several species originally placed in *Nesodillo* by Verhoeff may not belong here, but in *Cubaris* (Green, 1961). A revision of *Cubaris* by Green (1961) includes a key to species. A comprehensive revision of the entire genus, however, is needed. The above diagnosis is derived from Green (1961). The type specimens of *Cubaris murina* have been lost, preventing a unambiguous diagnosis. The status of *C. murina* should be stabilised by selection of a neotype, a task that is not within the scope of this paper. *Cubaris dhaliwali* does not fit any other described genera but does belong in the same group as species previously placed in Cubaris. Regardless of the best composition of *Cubaris* and without being able to examine the type material of *C. murina, C. dhaliwali* n.sp., fits the existing generic diagnosis.

Cubaris lewisae nom. nov.

Cubaris granulatus Lewis, 1998b (not *C. granulatus* Collinge, 1915b).

Remarks. Lewis (1998b) described a new species of *Cubaris* from Lord Howe Island that she named *C. granulatus*. This name has already been used by Collinge (1915b) for a species from India. These species are clearly different, and the species from Lord Howe Island must be given another name. We propose the name *Cubaris lewisae* nom. nov. to replace *C. granulatus* Lewis, 1998b.

Cubaris dhaliwali n.sp.

Figs. 15–17

Type material. HOLOTYPE ♂, P59956, 7.1 × 3.4 mm, QMB157. PARATYPES: P59960, ♀ 9.5 × 4.5 mm, QMB157; P59957, ♂, 5 SEM stubs, QMB157; P59959, ♂, 2 SEM stubs, QMB157; P59999, ♀, 3 SEM stubs, QMB157; P59958, ♂, QMB157; P59965, 1 ♀, 2 ♂♂, 6 juveniles, LHI126; P59966, 1 ♀, 1 juvenile, LHI139; P59963, 4 ♂♂, 2 ♀♀, 60 juveniles, QMB157; P59961, 7 ind., QMB157; P59962, 8 ind., QMB157.

Type locality. Transit Hill (Clear Place), Lord Howe Island, New South Wales, Australia, 31°31.5'S 159°05'E, leaf litter, vegetation: *Drypetes australascia, Cryptocarya triplinervis* and *Howea forsterana*, GBM,xi1979, QMB157.

Additional material: P59964, ♂, QMB156; P59973, ♀, GBM, QMB131; P59974, 6 ind, QMB132; P59975, 1 ind, QMB155; P59967, 1 ind, LHI196; P59968, 3 ind, LHI413; P59969, 2 ind, LHI428; P59970, 4 ind, LHI429; P59971, 1 ind, LHI430; P59972, 1 ind, LHI517; P34902, 3 inds, LHI 122; P34903, 6 inds, LHI 533; P34904, 1 inds, LHI119.

Diagnosis. *Dorsal surface* smooth; frons with short setae. *Pereon* epimera 1 lateral margin simple, ventral surface

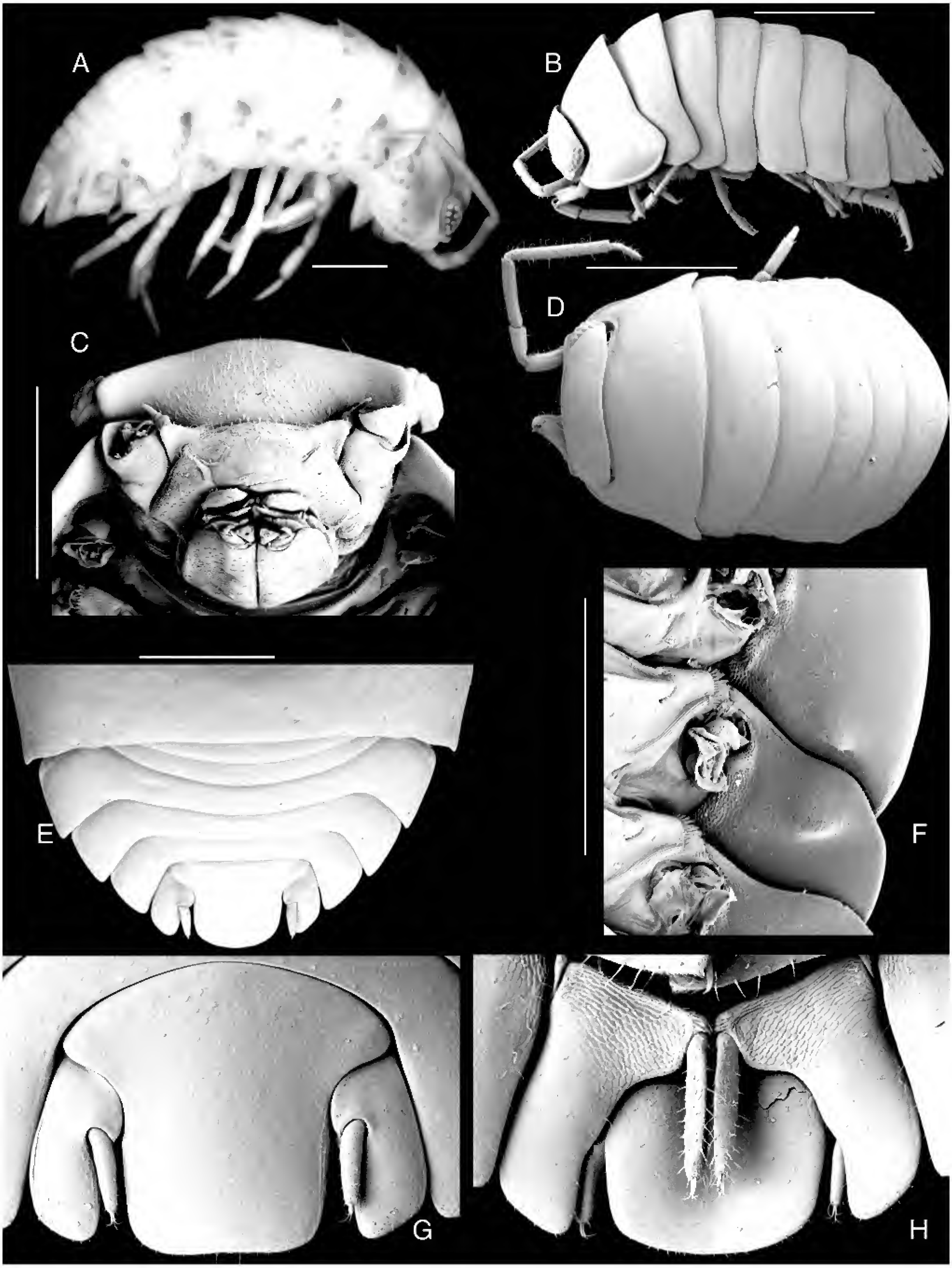

Figure 15. *Cubaris dhaliwali* n.sp. A, holotype ♂ (P59956); light micrograph, lateral view; B,D,E, paratype ♀ (P59999); B, lateral view; D, head and pereonites 1–6, dorsal view; E, pleon, dorsal view. C,F–H, paratype ♂ (P59959); C, head, ventral view; F, epimera 1–2 endolobes; G,H, pleotelson and uropods, G, dorsal view, H, ventral view. Scale bar = 1 mm.

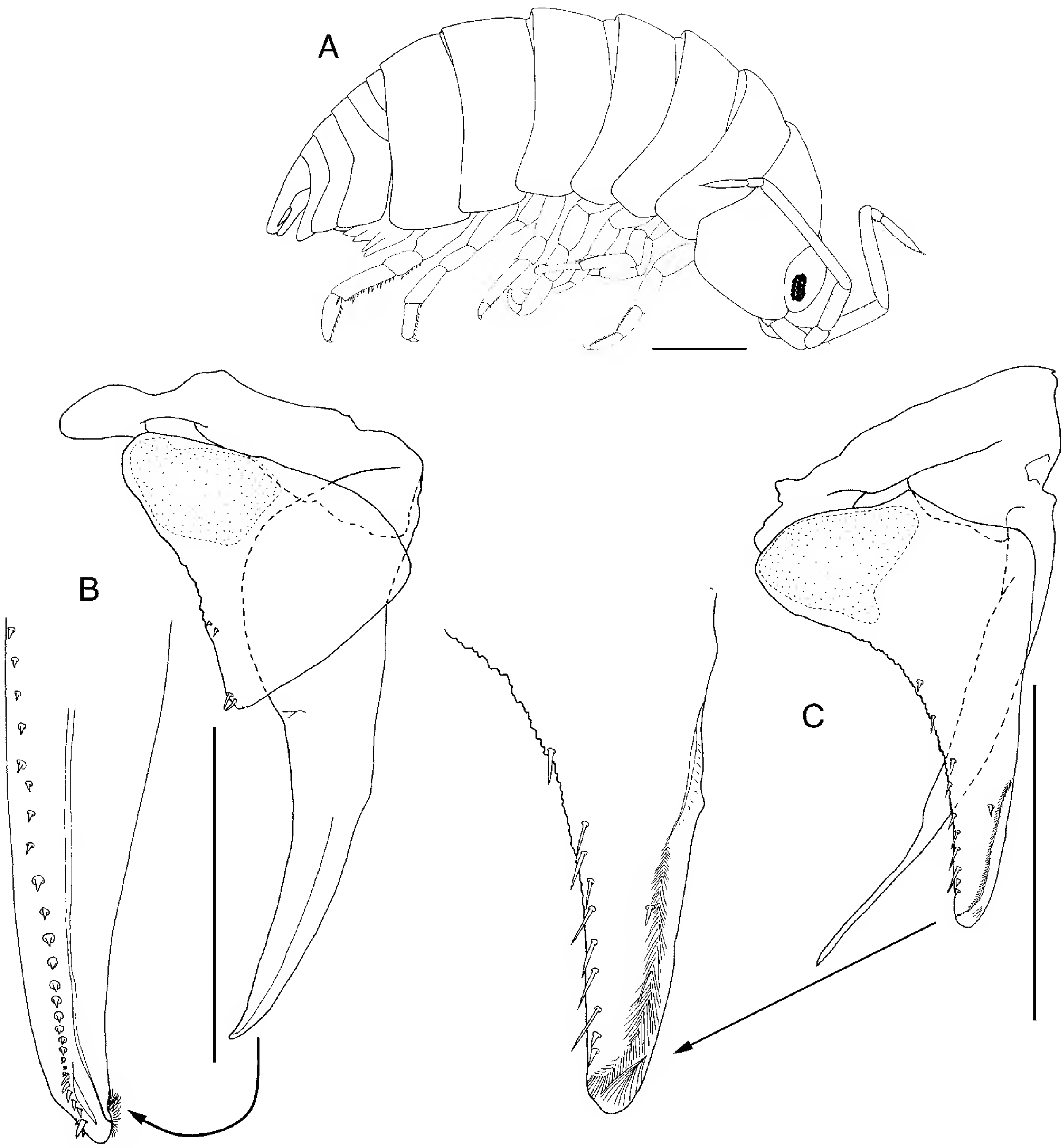

Figure 16. *Cubaris dhaliwali* n.sp. A, holotype ♂ (P59956), lateral view. B,C, paratype ♂ (P59958); B, pleopod 1, ventral view, and tip, dorsal view; C, pleopod 2 and exopod tip, ventral view. Scale bar = 1 mm.

endolobes small, rounded, closer to lateral margin than tergite junction, no ridge anterior to endolobe; epimera 2 anterior third of ventral surface thickened, endolobes small, round, near midline. *Pleotelson* posterolateral corners rounded, posterior margin straight, lateral sides parallel. *Male pereopods* 1, 2 and 3 carpus ventral side with brush of long setae with flat spoon-like tips increasing in length distally, decreasing in length from pereopod 1–3. *Male pleopod* 2 exopod row with long, thick setae along ventrolateral margin. *Uropod* protopod length 1.6 width, small gap between protopod distal portion and pleotelson.

Description. *Colour* pale brown with darker spots along pereonites posterior margins and epimera tergite junctions in alcohol. *Body* (Fig. 15A,B,D; 16A) strongly convex with vertical epimera. *Cephalon* (Fig. 15C,D) frontal lamina low, not raised above vertex, straight, lateral margins rounded; dorsal surface smooth, frons with short setae; head rounded, width 3.0 length. Eyes length equal to lateral head length, with 18–20 ocelli in adults, produced laterally. *Pereon* (Fig. 15A,B,D,F; 16A) epimera 1 anterior margin narrowly rounded, dorsal surface vertical to slightly convex, lateral margin simple, slightly sinusoidal when viewed ventrally, posterior margin slightly subrectangular, ventral surface endolobes small, rounded, closer to lateral margin than tergite junction, not connected to lateral or posterior margin, no ridge anterior to endolobe; epimera 2 anterior margin broadly rounded, posterior margin rounded rectangular, anterior third of ventral surface thickened, endolobes small, round, near midline; anterior margins of epimera 3–6

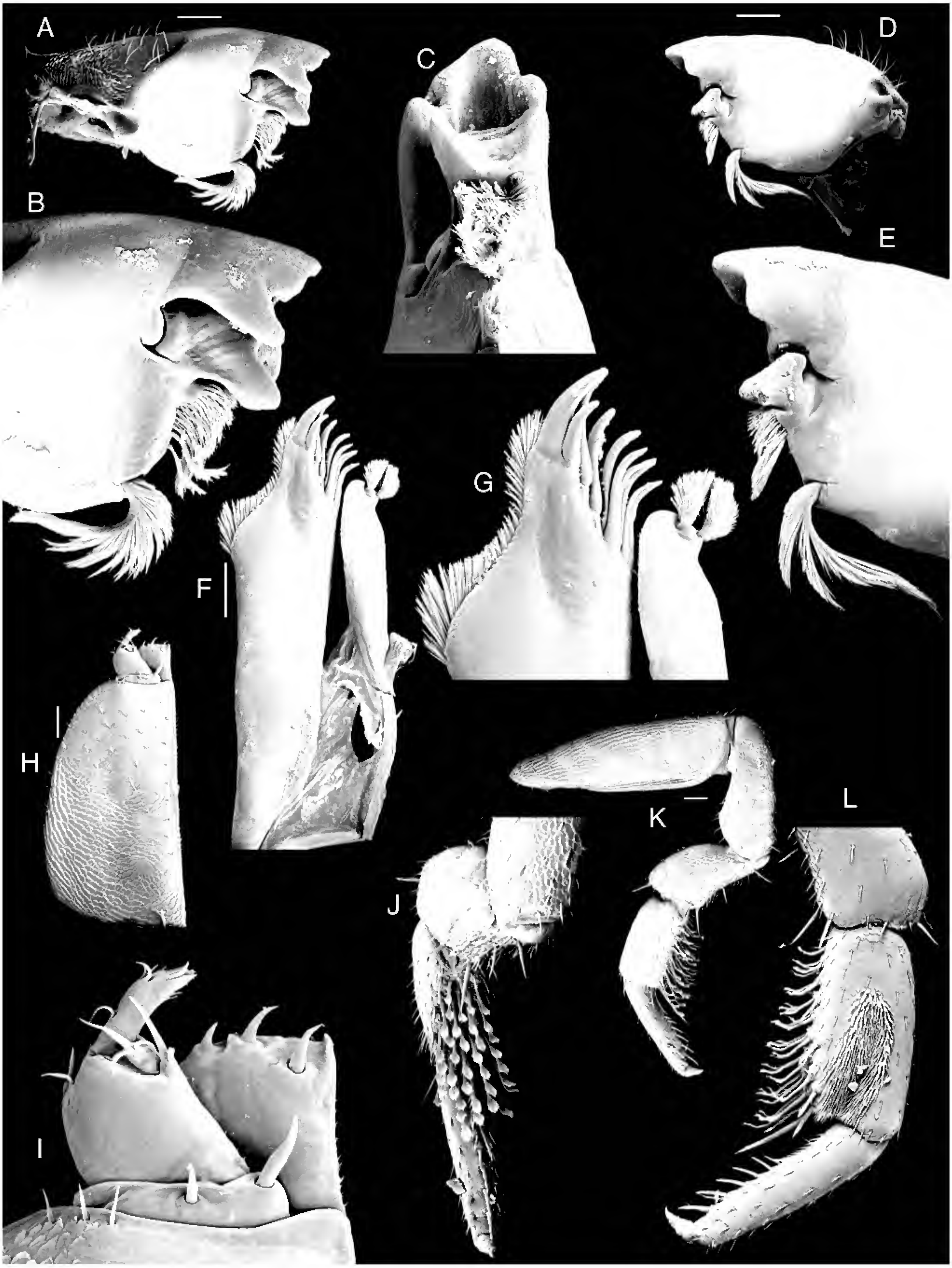

Figure 17. *Cubaris dhaliwali* n.sp. A–I, paratype ♀ (P59999); A–C, left mandible, A,B, dorsal view, C, medial view; D,E, right mandible, dorsal view; F,G, maxillule; H,I, right maxilliped. J–L, paratype ♂, pereopod 1 (P59957); J, ischium–dactylus, ventral view; K, posterior view; L, carpus-dactylus with antennal cleaning structure, anterior view. Scale bar = 100 µm.

broadly rounded, of epimera 7 rectangular; posterior margins of epimera 3–4 broadly rounded, epimera 5–7 increasingly rectangular and decreasingly angled posteriorly; epimera 3–7 endolobes absent; tergites 1–6 posterior margins slightly curved, tergite 7 posterior margin straight; tergite 1 length 0.25 pereon length; dorsal surface smooth. Noduli lateralis in one straight line on all pereonites on each side. *Pleon* (Fig. 15A) pleura anterior margin slightly rounded, posterior margin pointed; pleonites 1–2 posterior margin curved, pleonites 3–5 straight; dorsal surface smooth. *Pleotelson* (Fig. 15G) posterior margin rounded, sides parallel, length 0.9 width, dorsal surface smooth. *Antenna* (Fig. 15D) long, slender, reaching middle of epimera 4; flagellum length 0.6 article 5 length; flagellar article length proportions 1:3; all segments setose, more densely on flagellum. *Mandibles* (Fig. 17A–E). Left mandible setose lobe with two robust fan-shaped penicils and row of separate long simple setae between lacinia mobilis and molar process; right mandible setose lobe with group of short simple setae confined to lacinia mobilis base. *Maxilliped* (Fig. 17H,I) palp article 2 with apical group of setae on small lobe. *Male pereopods* (Fig. 17J–L) 1, 2 and 3 carpus ventral side with brush of long setae with flat spoon-like tips increasing in length distally, decreasing in length from pereopod 1–3. *Penes* ovoid, proximal bilobed lamellar process subtriangular, covering 0.2 penes length. *Male pleopod* (Fig. 16B,C) 1 exopod triangular, apex with two long setae, lateral margin with two setae, pseudotrachea along proximal lateral margin, width 0.5 exopod width, length 0.4 exopod length; exopod length 0.4 endopod length. Pleopod 2 exopod proximal wide portion length 0.33 exopod length, pseudotrachea along proximal lateral margin, width 0.5 exopod width, length 0.3 exopod length; row of long, thick setae along ventrolateral margin; endopod proximal article length 0.2 endopod length; exopod length 0.75 endopod length. Pleopod 3 exopod lateral margin near apex with 4 large setae; exopod 4 with two large setae on lateral margin; exopod 5 apex with row of fine setae; pleopods 3–5 exopods increasingly rounded; scales along lateral margin to apex; pleopods width 0.4 pleon width. *Uropod* (Fig. 15G,H) protopod length 1.6 width, proximal width 2.0 distal width, inner margin slightly wave-like, leaving gap between pleotelson and protopod distal portion, distal tip anteriorly rounded and posteriorly pointed, half protopod length visible dorsally; length (along inner margin of dorsally visible portion) less than 2.0 width (at point of exopod insertion); exopod length 0.5 protopod dorsally visible portion length, inserted dorsally ⅓ length to apex; endopod setose with longer apical setae than exopod, exopod length 0.6 endopod length; dorsal surface smooth.

Etymology. This species is named in honour of the first author's husband, Jack Dhaliwal.

Remarks. *Cubaris dhaliwali* n.sp. can be distinguished from the other species of *Cubaris* in the Australasian region by the following features ("*" indicates species originally placed in *Nesodillo* and may still belong in that genus):

- smooth dorsal surface [*C. chiltoni* Vandel, 1973, *C. hickmani* Green, 1961, *C. goweri* Lewis, 1998b, *C. lewisae* nom. nov., *C. merulanoides* (Wahrberg, 1922), *C. murina* Brandt, 1833, *C. nigroflava* (Wahrberg, 1922), *C. rufoniger* (Wahrberg, 1922) and *C. tasmaniensis* Green, 1961];
- pleotelson with parallel lateral sides and rounded posterolateral corners [*C. ambitiosa* (Budde-Lund, 1885), *C. fasciata* Lewis, 1998b, *C. ferruginea* Lewis, 1998b, *C. minilobus* Lewis, 1998b, *C. hirsuta* Lewis, 1998b, *C. tasmaniensis* Green, 1961, *C. marmorata* (Wahrberg, 1922), *C. sulcifrons* Green, 1961, *C. tamarensis* Green, 1961, *C. incisa* (Verhoeff, 1926)*, *C. plastica* (Verhoeff, 1926)*, *C. pronyensis* (Verhoeff, 1926)*, *C. canalensis* (Verhoeff, 1926)*, *C. lacustris* (Verhoeff, 1926)* and *C. pacifica* (Verhoeff, 1926)*];
- absence of a ridge in front of the endolobe on epimera 1 [*C. miser* (Budde-Lund, 1904)];
- lateral margin of epimera 1 not grooved (*C. lundi* Stebbing, 1900), shape of the uropods [*C. tarangensa* (Budde-Lund, 1904)];
- epimera 6 posterior margin without notch (*C. crenata* Lewis, 1998b).

Sphenodillo Lewis, 1998b

Sphenodillo Lewis, 1998b: 773.

Type species. *Sphenodillo agnostos* Lewis, 1998b by subsequent designation (not "*Sphenodillo howensis*", nomen nudum).

Remarks. *Sphenodillo* Lewis (1998b) is monotypic as originally described and "*Sphenodillo howensis*" was designated as the type species in that publication. Lewis (1998b), however, contains no description of "*Sphenodillo howensis*", so this name is a *nomen nudum*. Therefore, we designate *S. agnostos* Lewis, 1998b, the sole described species in the genus, as the type species of *Sphenodillo* Lewis, 1998b.

Key to the Armadillidae of Lord Howe Island (modified from Lewis, 1998b)

1 Epimera without endolobes (*Australiodillo*) 2

—— Epimera 1–2 with endolobes 7

2 Dorsal surface with sharp spines .... *Australiodillo primitivus* Vandel, 1973

—— Dorsal surface tuberculate 3

3 Epimera 1–2 anteroventral surface with shoulders .... *Australiodillo armus* Lewis, 1998b

—— Epimera 1–2 anteroventral surface without shoulders 4

4 Dorsal surface densely setose .... *Australiodillo setosus* Lewis, 1998b

—— Dorsal surface not densely setose 5

5 Pleonites 1–5 posterior margins without distinct midline tubercle .... *Australiodillo anomalus* Lewis, 1998b

—— Pleonites 1–5 posterior margins with distinct midline tubercle 6

6 Pleon dorsal tubercles sharp; body <12 mm long .... *Australiodillo insularis* Vandel, 1973

—— Pleon dorsal tubercles rounded; body >12 mm long......... *Australiodillo muscosus* Lewis, 1998b

7 Uropodal exopods absent....................................... *Pseudodiploexochus pacificus* Lewis, 1998b

—— Uropodal exopods present 8

8 Pleotelson divided into three parts separated by fine lines, middle section with two lateral tubercles .... *Orthodillo chiltoni* Vandel, 1973*

—— Pleotelson not divided into three parts 9

9 Pleotelson with heavy dorsal keel; endolobes rounded......... *Sphenodillo agnostos* Lewis, 1998b

—— Pleotelson without heavy dorsal keel 10

10 Epimera near horizontal; tooth-like endolobes 11

—— Vertical or angled epimera; rounded tubercles 16

11 Large club-like tubercles on pereon dorsal surface; high, uncleft frontal lamina .... *Stigmops howensis* (Lewis, 1998b)

—— Pereon dorsal tubercles not club-like; frontal lamina cleft or entire 12

12 Four high cephalic tubercles, ridge above eyes; frontal lamina cleft or indented 13

—— Cephalic tubercles lower than; frontal lamina entire 15

13 Frontal lamina indented .... *Stigmops odontotergina* n.sp.

—— Frontal lamina cleft 14

14 Cephalic tubercles not higher than pereon tubercles............................ *Stigmops polyvelota* n.sp.

—— Cephalic tubercles much higher than pereon tubercles..... *Stigmops demiclavula* (Lewis, 1998b)

15 Frontal lamina straight .... *Pyrgoniscus scopelicus* n.sp.

—— Frontal lamina curved forming three lobes .... *Pyrgoniscus intermedius* Lewis, 1998b

16 Dorsal surface densely setose .... *Cubaris hirsuta* Lewis, 1998b

—— Dorsal surface not densely setose 17

17 Epimera 6 posterior margin with notch .... *Cubaris crenata* Lewis, 1998b

—— Epimera 6 posterior margin without notch 18

18 Epimera 1 posterior margin sharply rectangular .... *Cubaris goweri* Lewis, 1998b

—— Epimera 1 posterior margin rounded/ subrectangular 19

19 Dorsal surface granulated; epimera 1 endolobe broadly rounded ...... *Cubaris lewisae* nom. nov.

—— Dorsal surface not granulated 20

20 Pleotelson sides parallel .... *Cubaris dhaliwali* n.sp.

—— Pleotelson hourglass-shaped 21

21 Pleotelson proximal width 0.95–1.05 distal width .... *Cubaris ferruginea* Lewis, 1998b

—— Pleotelson proximally wider than distally 22

22 Antenna flagellar article 1 length 0.25 article 2 length .... *Cubaris fasciata* Lewis, 1998b

—— Antenna flagellar article 1 length 0.5 article 2 length .... *Cubaris minilobus* Lewis, 1998b

Biogeography of Lord Howe Armadillidae

Armadillidae is a large family with 78 described genera and approximately 700 species. This family occurs mainly in the Southern Hemisphere, indicating a Gondwanan origin. Most genera are found in the southern African, Oriental and Australian-South Pacific regions with few representatives in the Neotropical region and only one in the Palaearctic (Mediterranean) region (Taiti *et al.*, 1998). The Australian-South Pacific region has the highest number of genera and highest endemism (Taiti *et al.*, 1998). Selected genera or geographical areas have been revised, but no author has yet made a comprehensive revision of the entire family. The taxonomy of the family is therefore confused and in need of a global revision. Phylogenetic relationships within the family are largely unknown and will be better understood after a revision. The following review of the biogeographic relationships of Lord Howe Armadillidae is derived from Taiti *et al.* (1998), the taxonomic references listed above for each genus and an unpublished thesis (Lillemets, 2001).

Cubaris, with approximately 119 nominal species found in all four Gondwanan regions (Table 2), is the largest and most widespread of the genera treated in this paper. Lord Howe Island alone has 8 species. Many species of *Cubaris* are found in the Americas (a total of c. 44 species, 11 in southern North America, 14 in Central America and the West Indies and 19 in South America). The Australian-Pacific region is also diverse with approximately 35 species. The Indian sub-continent has 19 species and 9 each in Africa and southeast Asia. One species has been described from Spain (*C. invenustus* Collinge, 1915a), although it may be an introduced species because most other *Cubaris* occur in the southern hemisphere or are on tropical islands. *Cubaris* is not monophyletic (Lillemets, 2001) and its geographic distribution may change with a comprehensive revision. The same statement applies to the non-monophyletic *Pyrgoniscus* (Lillemets, 2001).

Pyrgoniscus is the second largest genus with 19 described species worldwide, with 2 on Lord Howe Island. Members of this genus are found both in the African and Australian-South Pacific regions (Table 2), though most are found in the latter region (15 species). An African link is also indicated by the presence of *Pseudodiploexochus* on Lord Howe Island. Of the 22 species in this latter genus, 16 are from Africa, two from Madagascar and one each from Mauritius, Brazil, Western Australia and Lord Howe Island (Table 2). Until this paper, *Anchicubaris* represented another link to Africa. This link is, however, removed because the two previously described species do not belong in this genus and are now placed in the new genus *Stigmops*. *Stigmops*, with 4 species, is endemic to Lord Howe Island and appears to be related to *Pyrgoniscus*, based on preliminary phylogenetic analyses (Lillemets, 2001).

The monotypic genera *Orthodillo* and *Sphenodillo* are endemic to Lord Howe Island and have only been found in small numbers. Vandel (1973) described *Orthodillo* from a single specimen and no other records of the species are known. *Australiodillo* is endemic to Lord Howe Island, New Caledonia and Queensland. Of the 9 species in this genus, 6 are endemic to Lord Howe Island, 2 found in New Caledonia and one in Queensland (Table 2). Several previously described species from Lord Howe Island are are difficult to distinguish and may prove to be synonymous. Therefore, the diversity of Lord Howe *Australiodillo* may be more comparable to other regions.

Table 2. Worldwide distribution of Armadillidae taxa represented on Lord Howe Island.

genus	number of species	distribution
Australiodillo	9	Lord Howe Island, New Caledonia, Queensland
Cubaris	c. 119	Southern Hemisphere, southern North America, southeast Asia, Spain
Orthodillo	1	Lord Howe Island
Pseudodiploexochus	22	Lord Howe Island, Western Australia, South Africa, Tanzania, Zaire, Comoro I., Aldabra I., St. Helena I., Madagascar, Mauritius, Brazil
Pyrgoniscus	19	Lord Howe Island, Queensland, New South Wales, New Caledonia, Chatham I., "Eastern Seas", Madagascar, Kenya, Tanzania
Sphenodillo	1	Lord Howe Island
Stigmops	4	Lord Howe Island

The diversity of organisms on Lord Howe Island is high, much higher than what would be expected on an isolated island of its size. Many taxa possibly could have reached the island by long distance dispersal, using various biotic and abiotic methods. Some taxa present on the island, however, also have low dispersal abilities: Peloridiidae (Insecta: Hemiptera) (Evans, 1981) and Archontophoenicinae (Palmae: Areceae) (Pintaud, 1999). Armadillidae have achieved limited dispersal across large bodies of water, shown by the small number of species found on the Hawaiian Islands (Taiti & Ferrara, 1991). Never-the-less, eight different genera of Armadillidae are represented on Lord Howe Island, more than would be expected from anthropogenic introductions, as in Hawaii. Possible dispersal mechanisms of Armadillidae to oceanic islands might also include rafting on floating vegetation. For short distances, rafting may be possible, but over longer distances this method seems unlikely. An alternative hypothesis (Evans, 1981) suggests that these taxa are ancient relicts of a formerly widespread biota. Shoals of the submerged Lord Howe Plateau would have been exposed during previously low sea levels of the glacial periods, thus creating much larger terrestrial areas and possibly effective "stepping-stones" (Standard, 1961, 1963; Clark & Pickard, 1977; Hutton, 1986). Thus we would expect to see closer relationships with other land masses such as New Zealand, Australia and New Caledonia. The presence of armadillids and other non-marine fauna on tiny Ball's Pyramid supports a recent connection between this rock and Lord Howe Island, similar to the other adjacent rocks such as Mutton Bird Island. The Holocene rise in sea levels concomitantly would have caused a contraction in the ranges of the fauna of Lord Howe Island, as well as breaking any connections with nearby landmasses. In this case, we would then expect to observe vicariant distributions. Moreover, the contracting area of the island would increase species density above equilibrium levels. Whatever the cause, we are certain that the biogeographic relationships of Lord Howe Island have a historical explanation.

ACKNOWLEDGMENTS. We are grateful for the support from the NSW Terrestrial Invertebrate Taxonomy project. Several anonymous referees, Camilla Myers, Greg Rouse and Shane Ahyong contributed useful suggestions for the improvement of this manuscript. We also thank Winston Ponder for the use of his digital photomicrographic system, Sue Lindsey, Australian Museum SEM Lab, who assisted with drying and mounting the specimens and took the images in this paper, and Rick Johnson, who corrected the survey samples positions from Lord Howe Island.

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Manuscript received 23 August 2001, revised 19 September 2001 and accepted 4 December 2001.

Associate Editor: Shane T. Ahyong.

Records of the Australian Museum (2002) Vol. 54: 99–127. ISSN 0067-1975

A Review of the Genera of Pectinariidae (Polychaeta) Together with a Description of the Australian Fauna

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ABSTRACT. The polychaete worm family Pectinariidae is represented in Australian waters by five species (*Amphictene favona* n.sp., *A. uniloba* n.sp., *Pectinaria antipoda* Schmarda, 1861, *P. dodeka* n.sp. and *P. kanabinos* n.sp.). *Pectinaria antipoda* is redescribed and a neotype designated. Generic diagnoses are given for all genera including three not known from Australian waters. Additional characters are described for each genus that may facilitate the separation of species. A key to all genera and to species present in Australia is given, as are tables summarising the characters of all described species.

HUTCHINGS, PAT, & RACHAEL PEART, 2002. A review of the genera of Pectinariidae (Polychaeta) together with a description of the Australian fauna. *Records of the Australian Museum* 54(1): 99–127.

The family Pectinariidae is poorly known from Australian waters even though it is an easily recognised family with its characteristic "ice-cream cone"-shaped sandy tube. Day & Hutchings (1979) recorded three species in three genera from Australia. Fauchald (1977) recognised five genera worldwide, and elevated several previously recognised subgenera to full generic status, and has been followed in this study. Hartman (1941) recognised five genera or subgenera and provided a key to genera, but little discussion of them. She suggested that *Amphictene*, *Pectinaria* and *Cistenides* are more closely related to each other than to the other two genera, *Lagis* and *Petta*, but does not qualify this statement. Holthe (1986) in his study of the family did not follow Fauchald (1977) and only recognised two genera, *Pectinaria* and *Petta*, and four subgenera within *Pectinaria*, although he does not provide a key to subgenera and stated that "specific characters serve better than the subgeneric ones for the purposes of identification". He provides no reasons for accepting these as subgenera rather than as separate genera, other than it is a matter of opinion. Similarly, Day (1967) used the concept of the subgenera with no justification. Other studies on pectinariids by Long (1973) and Wolf (1984) have not accepted these subgenera. We have therefore provided a diagnosis for each genus together with a table providing the diagnostic characters for each species currently assigned to that genus, as well as a table listing the major characters distinguishing the genera.

The family name Pectinariidae Quatrefages, 1865 is used here following the ruling by the International Commission on Zoological Nomenclature (Opinion 1225, 1982) that the name Amphictenidae Grube, 1851 did not have priority over the name Pectinariidae based on common usage.

Although pectinariids are not abundant in benthic samples collected in Australian waters, they are regularly collected but are not easily identified to species as no keys are available. A comprehensive survey of the family was undertaken, examining material available in all Australian museum collections. Five species were distinguished, of which four are new. Two genera were represented. *Pectinaria antipoda* is redescribed and a neotype designated. At least one fossil species of *Pectinaria* has been recorded by Katto (1976), but only living species are included in the relevant table. A key to the world genera and Australian species is given. The distribution of each Australian species is illustrated, with an indication given as to its abundance.

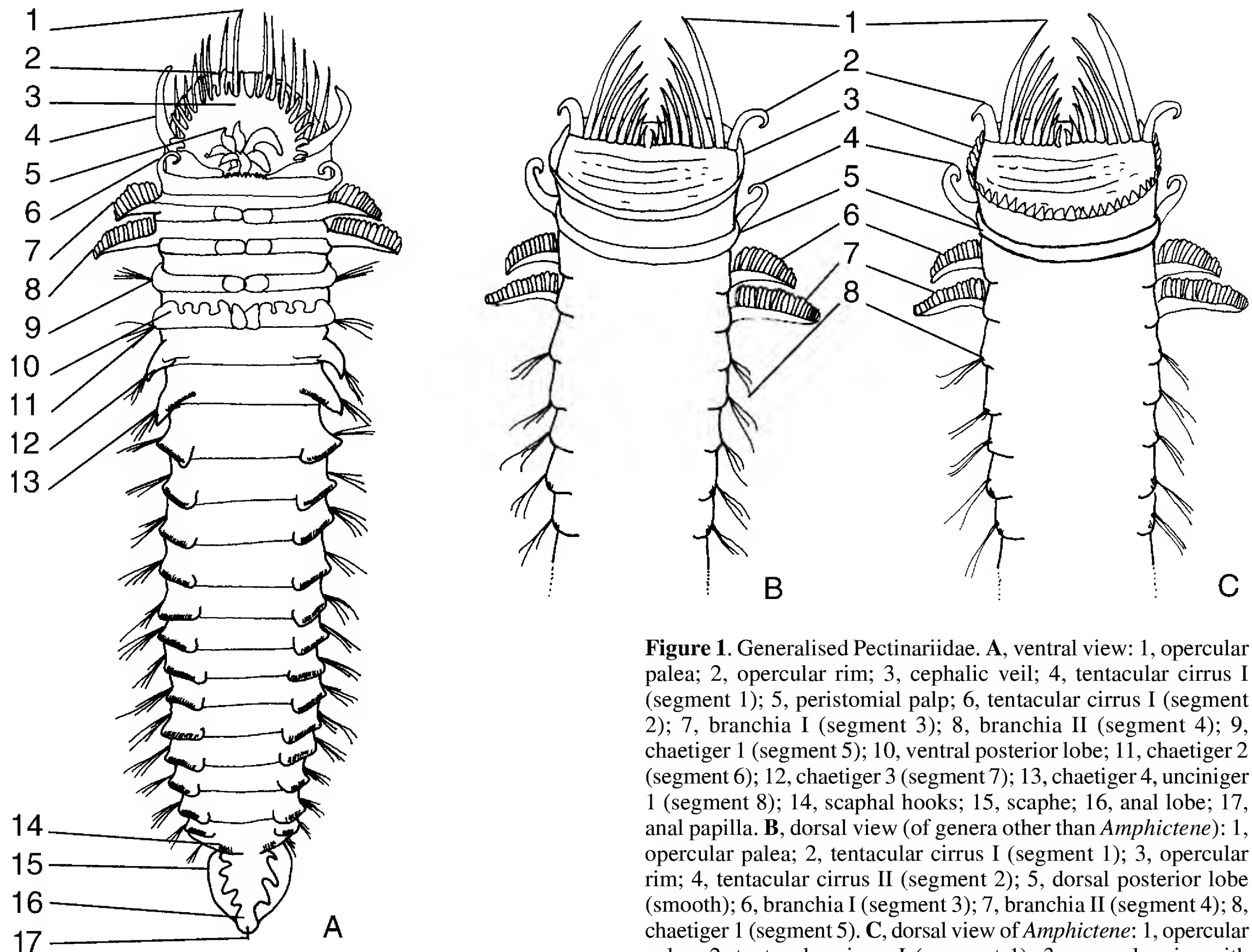


Figure 1. Generalised Pectinariidae. **A**, ventral view: 1, opercular palea; 2, opercular rim; 3, cephalic veil; 4, tentacular cirrus I (segment 1); 5, peristomial palp; 6, tentacular cirrus I (segment 2); 7, branchia I (segment 3); 8, branchia II (segment 4); 9, chaetiger 1 (segment 5); 10, ventral posterior lobe; 11, chaetiger 2 (segment 6); 12, chaetiger 3 (segment 7); 13, chaetiger 4, unciniger 1 (segment 8); 14, scaphal hooks; 15, scaphe; 16, anal lobe; 17, anal papilla. **B**, dorsal view (of genera other than *Amphictene*): 1, opercular palea; 2, tentacular cirrus I (segment 1); 3, opercular rim; 4, tentacular cirrus II (segment 2); 5, dorsal posterior lobe (smooth); 6, branchia I (segment 3); 7, branchia II (segment 4); 8, chaetiger 1 (segment 5). **C**, dorsal view of *Amphictene*: 1, opercular palea; 2, tentacular cirrus I (segment 1); 3, opercular rim with appendages; 4, tentacular cirrus I (segment 2); 5, dorsal posterior lobe; 6, branchia I (segment 3); 7, branchia II (segment 4); 8, chaetiger 1 (segment 5).

Methods

The following measurements were recorded for each animal: total length in mm, width of anterior segments and posterior segments. This information is given for type material and ranges given for the additional material examined. The width of anterior and posterior segments is given sequentially (e.g., 15 & 10 mm indicates that the specimen is 15 mm wide anteriorly and 10 mm posteriorly). Anterior width was measured at segment 3 and posterior width at the last chaetigerous segment. The presence or absence of coelomic gametes was noted, and in all cases sexually mature material was available for examination and indicated in the *material examined* sections with an "*". Notochaetae from chaetigers 4 and 14 and neurochaetae from chaetiger 8 were examined using SEM. Additional material examined for each species is listed by State in a west to east direction. In cases where a large amount of material was available, only a selection of the material examined is listed. All descriptions are based on the holotype unless stated, and the variation within paratypes or additional material examined is given in the variation section. The descriptions were generated using Delta to provide standardised species and generic descriptions (Dallwitz, 1980; Dallwitz *et al.*, 1993) and then edited. A schematic pectinariid (Fig. 1A–B) illustrating all the characters is given to facilitate the use of the key to the genera and species. In addition, the numbering of segments is given and the first segment on which noto- and neurochaetae occur. A key to all genera and Australian species is given, but does not imply any phylogenetic relationships.

The following abbreviations have been used in the text:

AM	Australian Museum, Sydney;
BMNH	The Natural History Museum, London;
HZM	Zoologisches Institut und Zoologisches Museum der Universität Hamburg;
LACM-AHF	Los Angeles County Museum, Los Angeles, formerly The Allan Hancock Foundation;
MV	Museum Victoria, Melbourne;
NTM	Museums and Art Galleries of the Northern Territory, Darwin;
QM	Queensland Museum, Brisbane;
SAM	South Australian Museum, Adelaide;
TMAG	Tasmanian Museum and Art Gallery, Hobart;
USNM	National Museum of Natural History, Washington, D.C.;
WAM	Western Australian Museum, Perth;
ZMB	Zoologisches Museum, Museum für Naturkunde der Humboldt-Universität, Berlin.

Taxonomy

The Pectinariidae form a clade with the Ampharetidae and Alvinellidae and belong to the Terebellida (Rouse & Fauchald, 1997). The characters defining the monophyly of the family include: cone-shaped tubes, the presence of a cephalic veil, and the development of a flattened scaphe with spine-like chaetae (Fauchald & Rouse, 1997).

Definition. Body divided into three sections thorax, abdomen and scaphe; thorax and abdomen of 22 segments of which 16–17 chaetigerous, and scaphe of 5 fused segments. Prostomium completely fused to peristomium and reduced. Peristomial palps (buccal antennae) grooved, present on or around the peristomial lips, and cannot be retracted into buccal cavity. Cephalic veil broad and thin, arising behind the peristomial palps. First segment completely fused to head, and expanded to form an opercular plate; the margins of which elevated to form the posterodorsal lobe (opercular rim), either smooth or cirrate. The opercular plate with two combs of notopodial paleae, often long and golden. Remaining notopodia with capillary notochaetae. Neuropodia with uncini having numerous subequal teeth arranged in one or more vertical rows. Scaphe with two combs of modified chaetae in the form of hooks. Two pairs of pectinate branchiae on segments 4 and 5.

Remarks. The tentacular cirri present on segments 2 and 3 have an unknown relationship to any other kind of cirri reported. Fauchald & Rouse (1997) suggest these tentacular cirri are not homologous to those found in other families, and may represent structures unique to the pectinariids.

While the terms abdomen and thorax are widely used within the family, the concept differs from that found in the closely related ampharetids. We have referred to the thorax as including the anterior achaetigerous segments and the initial chaetigerous segments with only notopodia. The term abdomen refers to all the following chaetigerous segments with both noto- and neuropodia as well as well as the last chaetigerous segment with notopodia. In contrast in the ampharetids, the thorax refers to all chaetigerous segments with both noto- and neuropodia and the abdomen to the posterior segments with only neuropodia.

The above definition is based on Rouse & Fauchald (1997) although we have expanded it.

Key to genera and Australian species of Pectinariidae

Genera not recorded from Australian waters are identified by the asterisk.

1 Cephalic veil cirrate. Scaphe distinctly separated from abdomen 2

—— Cephalic veil smooth. Scaphe indistinctly separated from abdomen .... *Petta**

2 Dorsal opercular rim smooth 3

—— Dorsal opercular rim cirrate .... (*Amphictene*) 5

3 Cephalic veil free. 13 biramous chaetigers 4

—— Cephalic veil laterally attached. 12 biramous chaetigers .... *Lagis**

4 Major teeth of uncini in 1 row .... *Cistenides**

—— Major teeth of uncini in 2 rows .... (*Pectinaria*) 6

5 First tentacular cirri arise from anterior margin of segment 2; posterodorsal lobe absent .... *Amphictene uniloba* n.sp.

—— First tentacular cirri arise from posterior margin of segment 2; posterodorsal lobe present .... *Amphictene favona* n.sp.

5 Anteroventral lobe of chaetiger 2 slightly incised forming glandular lobes (Fig. 14A) 7

—— Anteroventral lobe of chaetiger 2 with contiguous large rounded papillae, 12–19 present (Fig. 9A) .... *Pectinaria antipoda*

7 Paleae subacute with compact tips (Fig. 14A); cephalic veil with 16–28 cirri .... *Pectinaria dodeka* n.sp.

—— Paleae acute with extended tips (Fig. 16A); cephalic veil with 10–16 cirri .... *Pectinaria kanabinos* n.sp.

Amphictene Lamarck, 1818

Amphictene Lamarck, 1818: 89.–Fauchald, 1977: 120.
Pectinaria (Amphictene).–Holthe, 1986: 22.

Diagnosis. Rim of cephalic veil with numerous long cirri. Cephalic veil completely free from operculum forming dorsal semi-circle around numerous peristomial palps. Raised opercular margin cirrate. Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only, chaetigers 4 to 16 biramous with notopodia, neuropodia, notochaetae and neurochaetae, chaetiger 17 with notopodia and notochaetae only (giving ratio of number of pairs of notopodia to neuropodia 17/13). Notochaetae all smooth winged capillaries, some with hirsute surfaces and others with finely serrated margins. Neurochaetal uncini with major teeth arranged in two rows. Posterior 5 segments fused to form flattened plate or scaphe and distinctly separated from the abdomen.

Type species. *Amphitrite auricoma* Müller, 1776; subsequent designation by Hartman, 1959.

Remarks. Ten species of *Amphictene* have been described and two additional species are described in this paper. The major diagnostic features of these species are given in Table 1. Several species are poorly described and in some cases characters states have had to be assigned from non-type material. We have transferred one species previously described as *Pectinaria leioscapha* Caullery (1944) to the genus *Amphictene*, because the opercular rim is described as being cirrate.

Amphictene favona n.sp.

Figs. 2A–B, 3A–C, 4A–B, 5A–B, 6, Tables 1, 6

Amphictene crassa.–Hartman, 1966a: 363–364. *Not A. crassa* Grube, 1870.

Type material. HOLOTYPE: AM W25611, 40 mm long, 14 & 10 mm wide. PARATYPES: 2, BMNH 2001.70–71*, 68–69 mm long, 13–17 & 6–7 mm wide; 3, LACM-AHF POLY 2060*, 54–59 mm long, 14–17 & 5 mm wide; 3, USNM 187084*, 35–68 mm long, 10–21 & 5–8 mm wide; 11, AM W25403*, 40–72 mm long, 10–15 & 4–10 mm wide. All material collected by Pat Hutchings, 28.vi.1994.

Type locality. Western Australia: Abrohlos I., Wallabi Group, holotype 28°32'35.4"S 113°46'32.4"E paratypes collected from 28°32'35.4"S 113°46'32.4"E to 28°36'31.2"S 113°44'56.4"E, 45–47 m, in amongst white bleached algal nodules (Rhodoliths).

Additional material examined. WESTERN AUSTRALIA: S of islets near Gun I., South Group, 28°53'S 113°52'E, 9.iv.1976, 2, WAM 49-96*; 8 km NW of Gun I., South Group, 28°53'S 113°52'E, 11.v.1960, 56.7–64 m, coral rubble, sponge and seaweed, 3, WAM 48-96*; Point Samson, 20°38'S 117°12'E, 26.ix.1972, low tide, sandy mud, 1, AM W5493*; between Broome and Wallal, 18°58'S 122°14'E, ix.1931, 13 m, 1, AM W2842*; Ashmore Reef, 12°15'S 123°00'E, 11.ix.1986, reef flat, 1, WAM 41-96*. QUEENSLAND: No. 2, Sandbank, Michaelmas Reef, near Cairns, 16°35'S 146°02'E, 7.viii.1971, 1, AM W25404; vi.1926, 1, AM W2317*, 1, AM W2318*; Brampton I., 20°49'S 149°17'E, 1949, 1, AM W5611*; Hayman I., 20°03'S 148°53'E, 1, AM W3150*; One Tree I., 23°30'30"S 152°05'E, 4.x.1967, 1 m, 1, AM W25405*. Material examined varied from 35 to 97 mm long & 10 to 16 & 10 to 6 mm wide.

Table 1. Major distinguishing characters of species of *Amphictene* (entries in parentheses are based on non-type material); † no type designated.

species	holotype length mm	holotype anterior width mm	cephalic veil, nos. of cirri	nos. of pairs of paleae	shape of paleae	opercular rim, nos. of cirri	posterodorsal lobe (segment 2)	anteroventral lobe (chaetiger 2)
A. auricoma (O.F. Müller, 1776)	†(20–40)	(3–9)	(12–20)	(10–15; 25 on v. large animals)	(acute, elongate thin tips curled over)	(15–25)	(absent)	(present—glandular, with 2 mid ventral lobes)
A. auricoma mediterranea (Nilsson, 1928)	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*	25	*n.r.*	*n.r.*
A. capensis (Pallas, 1776)	(15–90)	(3.5)	(20–30)	(11–15)	(elongate, curved dorsally, wide)	(20–26)	(absent)	(glandular)
A. catharinensis (Grube, 1870)	31	10	(40–50)	(11–12)	(elongate)	(10)	(*n.r.*)	(glandular)
A. crassa (Grube, 1870)	40 (40–100)	15 (15–25)	32 (27–32)	12 (12–18)	wide, recurved (acute)	56 (50–60)	*n.r.*	*n.r.* (cirrate—24)
A. favona n.sp.	40 (35–97)	7–17 (10–26)	28 (23–25)	12	subacute, blunt, curved dorsally	62 (61–63)	present, well developed, scalloped slightly	cirrate: 24 (23–25) broad triangular appendages
A. guatemalensis (Nilsson, 1928)	11	*n.r.*	20	9	curved dorsally, rolled tip	13	*n.r.*	cirrate—6 cirri per side
A. japonica (Nilsson, 1928)	incomplete (3–60)	8	v. small, unable to count (12–14)	13–14 (10–12)	curved (thick, flat, distally pointed)	24 (21–25)	*n.r.*	glandular
A. leioscapha (Caullery, 1944)	*n.r.*	*n.r.*	20	10	acute tips	with denticles	*n.r.*	*n.r.*
A. moorei (Annenkova, 1929)	32	*n.r.*	35–40	12	short curved, with fine tips	*n.r.*	*n.r.*	wide, and lobed
A. souriei (Fauvel, 1949)	63	7	long (many)	11–12	filiform tip	40	absent	glandular
A. uniloba n.sp.	29 (20–45)	4–2 (4–6)	16 (11–21)	14 (10–16)	subacute, curved dorsally, elongate	26 (21–31, nos. size dependent)	absent	glandular, smooth

Table 1 (continued). Major distinguishing characters of species of *Amphictene* (entries in parentheses are based on non-type material).

species	chaetigers on which notopodia reduced	nos. of rows of teeth per uncinus	nos. of teeth within a row on uncinus	scaphal shape	scaphe: anal flap	scaphal hooks: nos. of pairs & type	tube, shape & construction	glandular areas	type locality	additional records and comments*
A. auricoma s.st.	(1–3)	(3)	(5–6)	(elongate, longer or long as wide, crenulate edge)	(twice as long, or longer than wide; with long cirrus)	(8–18; size dependent; distally curved)	(curved, black—grey sand grains)	(strongly glandular)	Denmark—"type is probably lost or never designated" (Holthe, 1986)	(See below) [a]
A. a. mediterranea	*n.r.*	2	7–8	as long as broad, crenulate edge	short, as long as broad with small cirrus	10–16	dark brown, a variety of forms (locality dependent)	strongly glandular	Naples, Palmero & Pischio, Mediterranean Sea	(See below) [b]
A. capensis	(1–3)	(2–3)	(6–8)	(broader than long, oval, lobed margin)	(small shield shaped with small cirrus often missing)	(5–8)	(straight—made of sponge spicules)	(*n.r.*)	Cape of Good Hope	(See below) [c]
A. catharinensis	(1–3)	(2)	(6–7)	(*n.r.*)	(*n.r.*)	(20)	(*n.r.*)	(strongly glandular)	Desterro, Brazil	Redescribed by Nilsson (1928).
A. crassa	*n.r.* (1–3)	1? (2)	8–10 (6–10)	broader than long, lobed, 6 sided	*n.r.* (crenulated margin with small cirrus)	10 (6–20)	curved (coarse grains, thin walled)	*n.r.* (strongly glandular)	New Caledonia	(See below) [d]
A. favona n.sp.	1–3 & 15–18	2	7–8	broader than long, crenulated	present	16, broad, golden brown, blunt	straight, pale shell fragments	strongly glandular on chaetigers 4–18	Wallabi Group, WA, Australia	See Fig. 5 for distribution.
A. guatemalensis	1–3	4–5	6	wide-oval, lobed edges	semi-circular, lobed—no cirrus	9–10	*n.r.*	glandular	West coast of Central America, Guatemala	Known only from original description.
A. japonica	*n.r.*	2	7 (8)	missing (oval)	missing (smooth margin)	25 (9–24)	*n.r.*	strongly glandular	Japan	(See below) [e]
A. leioscapha	1–3, 17	2–3	8	broader than long	tongue-shaped with small cirrus	12	sand grains and forams	*n.r.*	Banda, Indonesia	Known only from single specimen.
A. moorei	*n.r.*	1	6–7	oval with lobed margins	short, wide & smooth with small cirrus	9–10	curved, brown grains, clear cement	*n.r.*	East coast of Siberia 132–159.7 m	Known only from original description.
A. souriei	none	2	6–7	long, oval with lobed edges	triangular, no anal cirrus present	6–7	straight, small round sand grains	*n.r.*	Hann Beach, Dakar, West Africa	(See below) [f]
A. uniloba n.sp.	1–3 & 15–18	2	8	broader than long, convoluted margin	present with small cirrus	6 (4–10), fine, small brown	straight, brownish, clear sand grains	strongly glandular	Jibbon Beach near Cronulla, NSW, Australia	See Fig. 5 for distribution.

n.r. character not recorded.

* Only a selection of records are given based on the literature to indicate distribution of species; however distributions outside the region of the type locality require verification.

[a] [*auricoma*] Widely recorded from Sweden and Norway (Malmgren, 1866, 1867); Gulf of Naples (Claparède, 1868); North Sea (Fauvel, 1927); Swedish west coast, 20–30 m (Hessle, 1917); Atlantic Ocean, Arctic Sea, Northern Pacific Ocean (Nilsson, 1928); Mediterranean Sea (Annenkova, 1929); Scandinavia (Holthe, 1986). Notochaetae with finely denticulate tips. Considerable variation recorded for this species.

[b] [*auricoma mediterranea*] Nilsson (1928) synonymised *Amphictene auricoma* described by Claparède (1868), Marenzeller (1874) and Panceri (1875); and *P. auricoma* described by Grube (1850, 1861, 1864) and Lo Bianco (1893) with his new subspecies, all records from the Mediterranean Sea. Not recorded since.

[c] [*capensis*] Recorded from S & E coast of Africa in 1298 m (Nilsson, 1928; Day, 1955, 1967). Some notochaetae with finely serrated tips.

[d] [*crassa*] Recorded from New Caledonia, Palau, Sri Lanka (Nilsson, 1928), India (Fauvel, 1953). Record by Hartman (1966a) from Sydney referred to *A. favona* (this study).

[e] [*japonica*] Also recorded by Imajima & Hartman (1964) from Japan. Some notochaetae with finely denticulate tips.

[f] [*souriei*] Known only from original description– distinguished by 4 large tubercules on the dorsum at level of branchiae. Some notochaetae with finely denticulated tips.

Other material examined. Holotype of *Pectinaria (Amphictene) crassa* Grube, 1870, ZMB 5704, New Caledonia.

Description. Preserved specimen pale cream to grey in colour. Body, robust and solid. Tube forming slightly tapered cylinder, resembling a tusk, composed of cemented shell fragments.

Rim of cephalic veil with 28 long cirri; cirri basally triangular, tapering to form thread-like terminal filaments. Cephalic veil completely free from operculum forming dorsal semi-circular lobe, which covers the bases of numerous peristomial palps. Raised opercular margin well developed, crenulated with 62 triangular lappets. Operculum with 12 pairs of paleae, short, golden, subacute, curved dorsally, without extended tips (Fig. 2A).

First pair of tentacular cirri arise from posterolateral margin of segment 2. Second pair of tentacular cirri present on segment 3, arise from a connecting ridge, which runs across the venter, margins of which expanded to form thin, flattened, rounded flaps. Segment 2 with posterodorsal lobe present and with scalloped margin. Venter of segments 3 and 4 slightly glandular and smooth. Chaetiger 1 (segment 5) without an anteroventral lobe. Chaetiger 2 with anteroventral lobe large and broad, anterior margin of lobe with contiguous rounded papillae, 24 present (Fig. 2A).

Two pairs of comb-like stalked branchiae on segments 3 and 4, situated laterally and each consisting of a series of loose, flat lamellae; anterior pair attached more ventrally than posterior pair, larger than posterior pair. Branchiae lie flattened against the body. Large subquadrate glandular flaps present ventrally at base of second pair of branchiae on segment 4.

Chaetigers 1 to 3 (segments 5 to 7) with notopodia only. Chaetigers 4 to 16, biramous with notopodia, neuropodia, notochaetae and neurochaetae. Chaetiger 17 with notopodia and notochaetae only. Chaetigers 1 to 3 and 15 to 17 with both notopodia and notochaetae reduced in length compared to those on chaetigers 4 to 14. All notochaetae smooth-winged capillaries with finely hirsute surfaces and some margins slightly pectinate (Fig. 4A–B), some notochaetae straight, others with slightly curved tips (Figs. 3A, 4A–B). Neuropodia wedge-shaped, slightly glandular, erect tori, with numerous neurochaetae. Neurochaetal uncini with major teeth arranged in two longitudinal rows, each with 8 to 10 teeth, with size of teeth declining basally (Figs. 3B–C, 5A).

Posterior 5 segments fused to form scaphe broader than long; distinctly separated from preceding abdomen. Scaphe with lobed margins, and an anal flap with a dorsal papilla present (Fig. 2B). Scaphal hooks present, 16 pairs; broad, blunt, golden-brown (Fig. 5B).

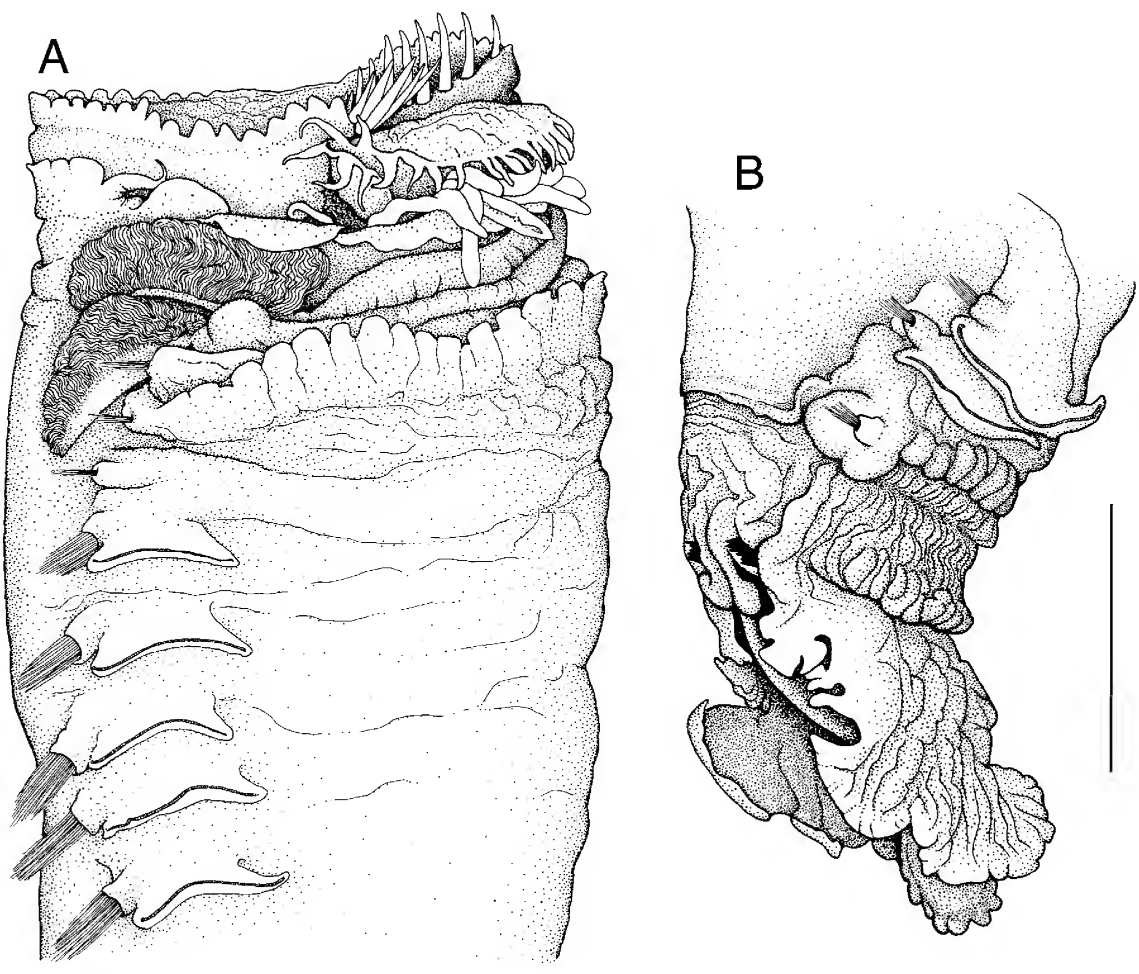


Figure 2. *Amphictene favona* n.sp. A, lateral view of anterior end of holotype (AM W25611). B, posterior end of paratype (AM W25403). Scales = 5 mm.

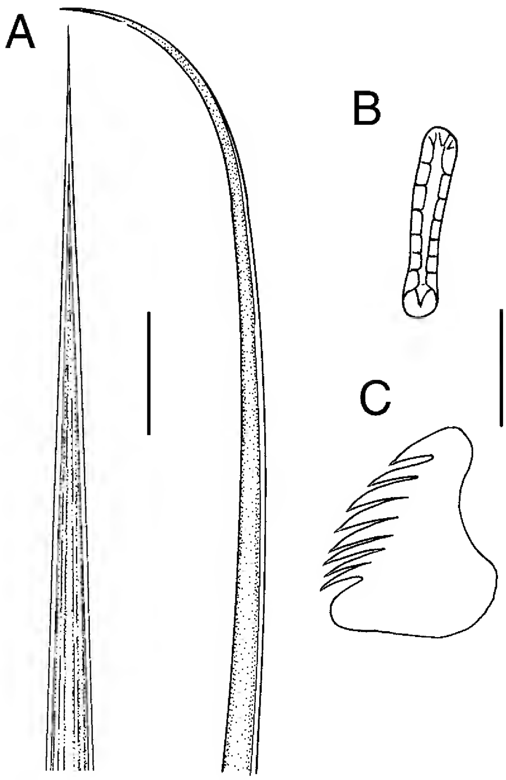


Figure 3. *Amphictene favona* n.sp. Holotype (AM W25611). A, two types of notochaetae from chaetiger 5. B, frontal view of neurochaeta from 8th uncinigerous segment. C, lateral view of neurochaeta from 8th uncinigerous segment. Scales = 100 µm.

Chaetigers 4 to 18 with prominent paired, ventral glandular patches, rectangular with rounded margins. Small thin, film-like flaps present on second prescaphal segment.

Nephridial papillae present on segments 5 and 6 (chaetigers 1 and 2), rounded, situated ventrolaterally below base of second pair of branchiae.

Variation. Some immature individuals have only one pair of nephridial papillae present on chaetiger 1, two pairs present on mature individuals. Within the material examined, the number of cirri on the cephalic veil margin varies between 23 and 28, with larger animals having more cirri than smaller ones. In addition, the number of lappets on the opercular margin varies from 61 to 63 and the number of papillae on the anteroventral lobe of chaetiger 2 varies from 23 to 25; in general the higher counts are present on larger animals. The orientation of the branchiae varies between individuals, some have the branchiae completely flattened against the body whereas in others they are held away from the body. This may be an artifact of preservation, or a real difference among individuals.

Remarks. *Amphictene favona* n.sp. can be distinguished from all other described species of *Amphictene* (see Table 1) by the following combination of characters: relatively few cirri on the cephalic veil (23 to 28), large numbers of cirri on the operculum (61 to 63), and 16 pairs of scaphal hooks, with relatively little variation occurring between large and small individuals. The number of pairs of scaphal hooks distinguishes this species from all other described species. *Amphictene favona* most closely resembles *A. capensis* (Pallas, 1776), *A. uniloba* n.sp., *A. crassa* (Grube, 1870) and *A. japonica* (Nilsson, 1928) in terms of sharing one of its diagnostic characters.

Hartman (1966a) recorded *Amphictene crassa* from Australia, giving no locality data. The specimen was brought into the Australian Museum for identification by a member of the public. Re-examination of this specimen (AM W3802) showed that it is *Amphictene favona* n.sp. and not *A. crassa*, so no valid records for the latter species exist from Australian waters. The specimen was most likely collected in New South Wales, extending the known range of the species (but not indicated on Fig. 6, due to the uncertain nature of the record). The individual was compared with the type of *A. crassa* (Grube, 1870) (ZMB 5704), which was described from New Caledonia and differs from this species in having fewer pairs of scaphal hooks. The records of this species from Palau, Sri Lanka (Nilsson, 1928) and those from India (Fauvel, 1953) may also be misidentifications.

Etymology. The specific name *favona* refers to the westerly winds, which blow almost continually on the Abrohlos Islands, and is based on the latin word for "west wind".

Distribution. Northeastern Australia and northwestern Australia (see Fig. 6).

Habitat. Found in depths ranging from intertidal to 64 m, in soft sediments, often in amongst bleached algal nodules and typically associated with coral reefs.

Amphictene uniloba n.sp.

Figs. 4C–D, 5C–D, 6, 7A–B, 8A–C, Tables 1, 6

Type material. HOLOTYPE: AM W25612*, 29 mm long, 4 & 2 mm wide. PARATYPES: 3, AM W25613*, 28–33 mm long, 5–6 & 2–3 mm wide; 2, BMNH 2001.68–69*, 31–32 mm long, 5–6 & 2–3 mm wide; 2, LACM-AHF POLY 2059*, 20–32 mm long, 5 & 3 mm wide; 2, USNM 187085 *, 28–35 mm long, 5 & 3 mm wide. All material collected by John McIntyre, 5.xii.1965.

Type locality. New South Wales: near Cronulla, Jibbon Beach, 34°03'S 151°09'E, 60–100 m.

Additional material examined. QUEENSLAND: Pallarenda Beach, N of Townsville, 19°12'S 146°46'E, 11.xi.1977, 0.1 m, 1, AM W18121*. NEW SOUTH WALES: Port Stephens, 32°42'S 152°06'E, ix.1908, 1, AM G11197*. Material examined varied from 20 to 45 mm long & 4 to 6 mm & 2 to 3 mm wide.

Description. Preserved specimen grey to pale cream in colour; small, conical in shape. Tube straight, composed of cemented sand grains.

Rim of cephalic veil with 16 long, narrow, triangular cirri, tapering, with thread-like tips. Cephalic veil completely free from operculum forming dorsal semi-circular lobe covering bases of numerous peristomial palps present. Raised opercular margin well developed, divided into 24 triangular lappets. Operculum with 14 pairs of paleae, long, yellow-gold, subacute, curved dorsally, with extended tips (Fig. 7A).

First pair of tentacular cirri arise on anterior margin of segment 2. Second pair of tentacular cirri present on segment

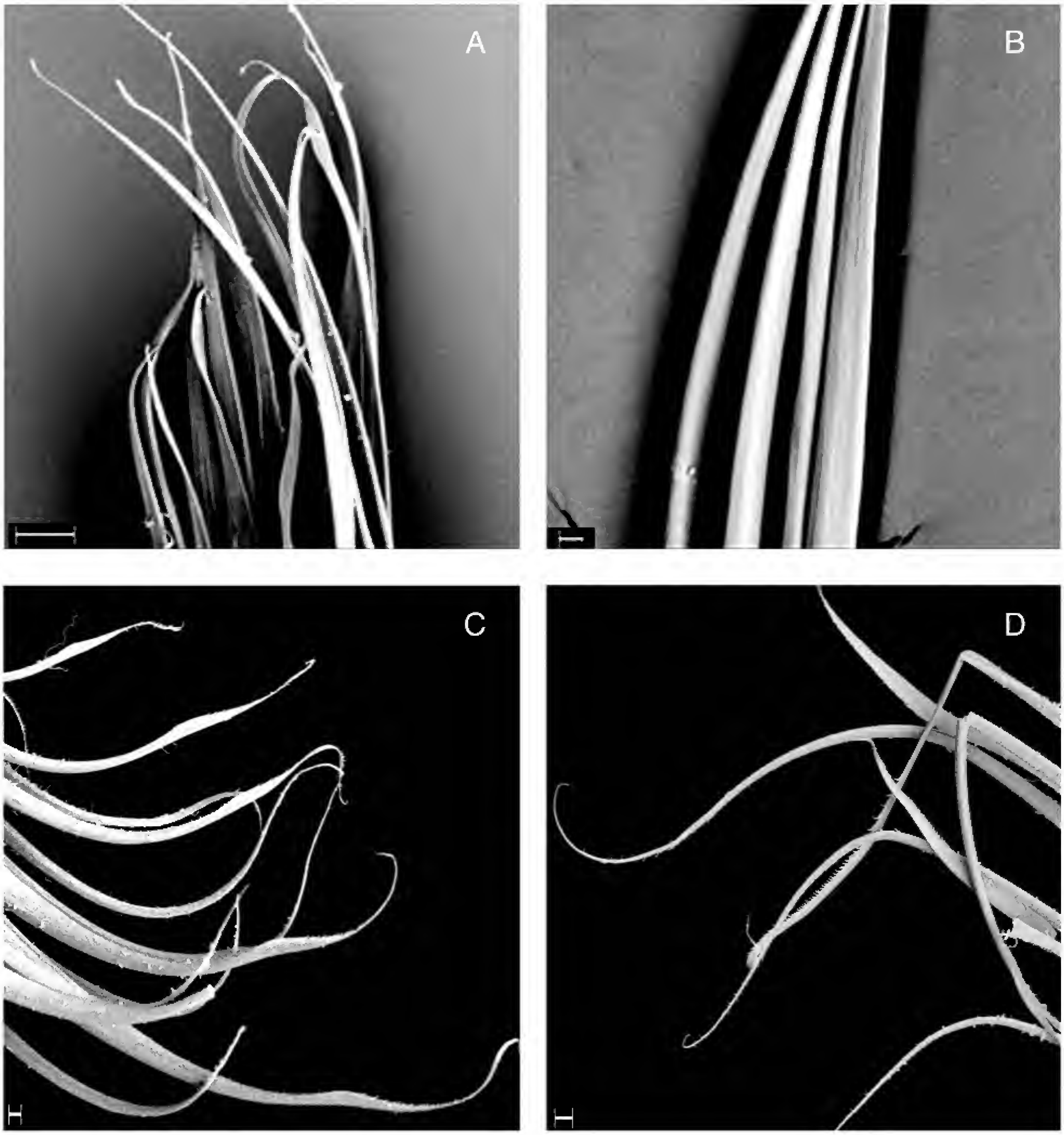


Figure 4. A, *Amphictene favona* n.sp. notochaetae from chaetiger 4, scale = 100 µm. B, *Amphictene favona* n.sp. notochaetae from chaetiger 14, scale = 10 µm. C, *Amphictene uniloba* n.sp. notochaetae from chaetiger 4, scale = 10 µm. D, *Amphictene uniloba* n.sp. notochaetae from chaetiger 14, scale = 10 µm.

3, arise from a connecting ridge which runs across the venter, margins of ridge incised forming glandular lobes. Segment 2 without anterodorsal lobe. Chaetiger 2 (segment 6) with large, anteroventral lobe, broad, with anterior margin of lobe smooth, lobe thin and almost transparent.

Two pairs of comb-like, stalked branchiae on segments 3 and 4, situated laterally and consisting of loose flat, lamellae. Anterior pair situated more ventrally than posterior pair, and larger than posterior pair. Branchiae lie flattened against the body.

Chaetigers 1 to 3 (segments 5 to 7) with notopodia only. Parapodia biramous with both notopodia, neuropodia, notochaetae and neurochaetae on chaetigers 4 to 16. Chaetiger 17 with notopodia and notochaetae only. Notopodia of chaetigers 1 to 3 and 15 to 17 reduced in size, and associated notochaetae also reduced in size and length compared to notosetae on chaetigers 4 to 14. All notochaetae simple, smooth-tipped capillaries, with finely hirsute surfaces, and varying from ones with finely pointed tips to those with strongly curved tips and some with pectinated margins (Figs. 4C–D, 8A), all of which may be present in the same fascicle. Neuropodia wedge-shaped, slightly glandular, erect tori with numerous neurochaetae. Neurochaetal uncini with major teeth arranged in two longitudinal rows of teeth each with about 8 teeth per row, with size of teeth declining basally (Figs. 5C, 8B–C).

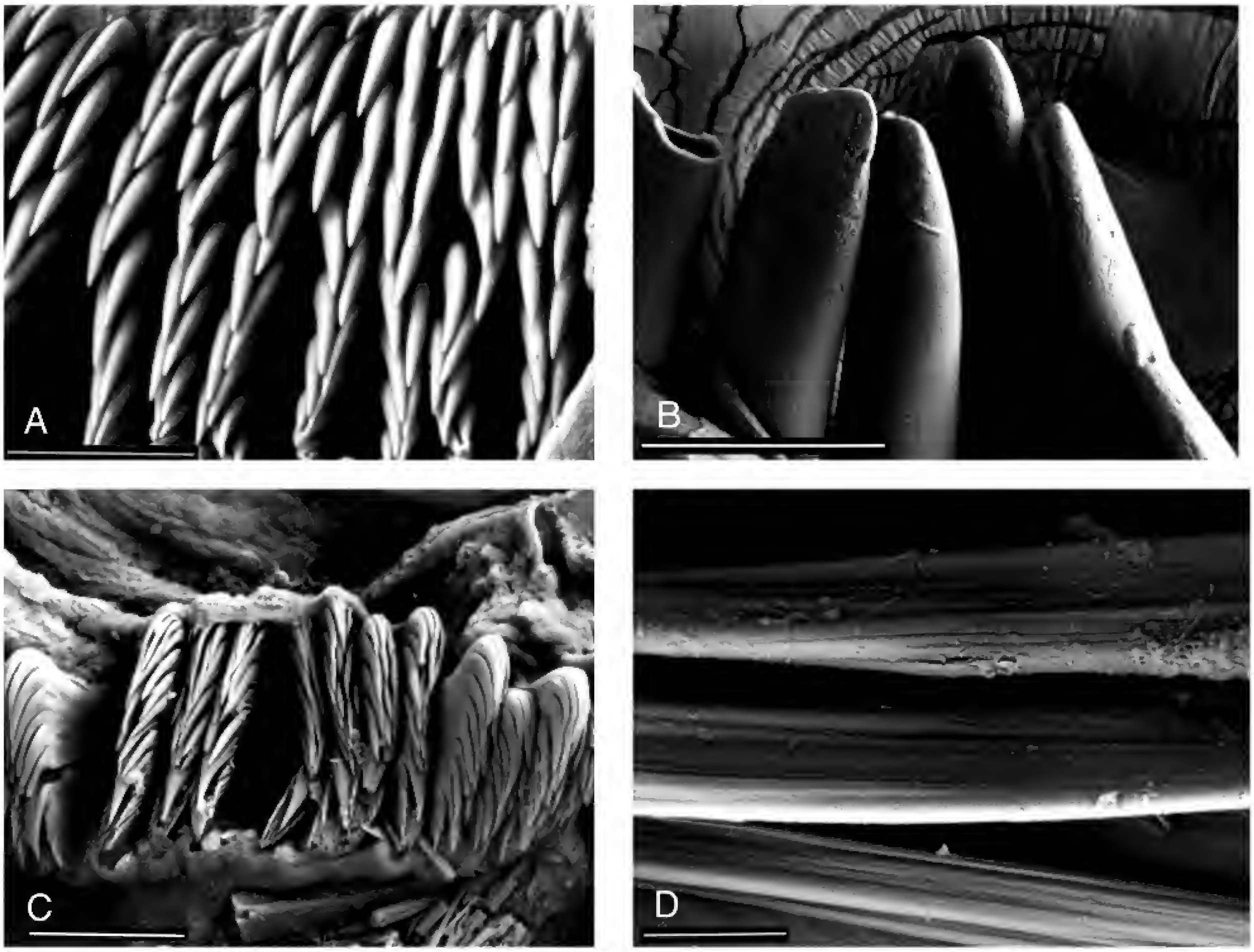


Figure 5. A, *Amphictene favona* n.sp. neurochaetae from chaetiger 8, scale = 20 µm. B, *Amphictene favona* n.sp. scaphal hooks, scale = 100 µm. C, *Amphictene uniloba* n.sp. neurochaetae from chaetiger 8, scale = 20 µm. D, *Amphictene uniloba* n.sp. scaphal hooks, scale = 3 µm.

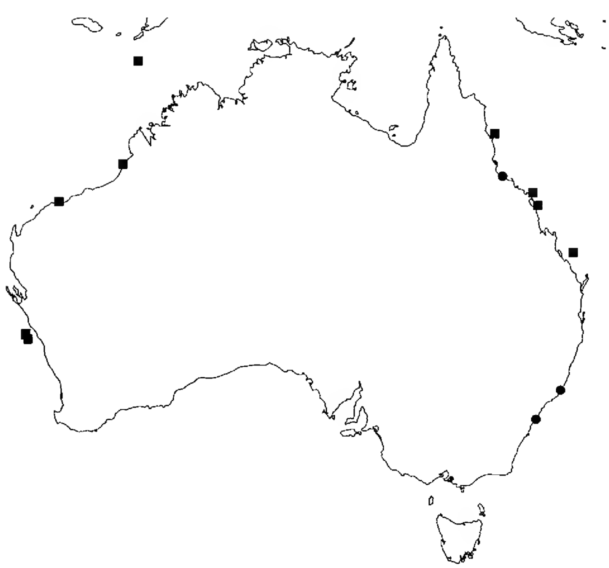


Figure 6. Distributional map for the Australian species of *Amphictene*. ■ *Amphictene favona* n.sp. ● *Amphictene uniloba* n.sp.

Posterior 5 segments fused to form a flattened plate or scaphe, broader than long. Scaphe with an anal flap and dorsal papilla present, and with crenulated, lobed margins (Fig. 7B). Scaphal hooks present, 6 pairs, fine, small and brown (Fig. 5D).

Venter of segments 1 to 6 glandular, raised and corrugated. Chaetigers 7 to 20 with prominent oval to rectangular glandular patches present ventrolaterally. Nephridial papillae present on segment 5 (chaetiger 1), situated ventrolaterally just below base of second pair of branchiae.

Variation. The number of cirri on the cephalic veil ranges from 11 to 21; the number of triangular lappets on the raised opercular margin varies from 21 to 31 lappets; the relative size of the two pairs of branchiae differ, either being similar in size or with the anterior pair larger. The number of pairs of scaphal hooks varies from 4 to 10 and the development of the glandular areas varies between individuals. Larger animals have more cirri, lappets and scaphal hooks than smaller animals. The relative proportions of the scaphe varies between individuals. It may be as long as broad or longer than broad. This may be an artifact of preservation.

Remarks. *Amphictene uniloba* n.sp. can be distinguished from all other described species of *Amphictene* by the following combination of characters: relatively small

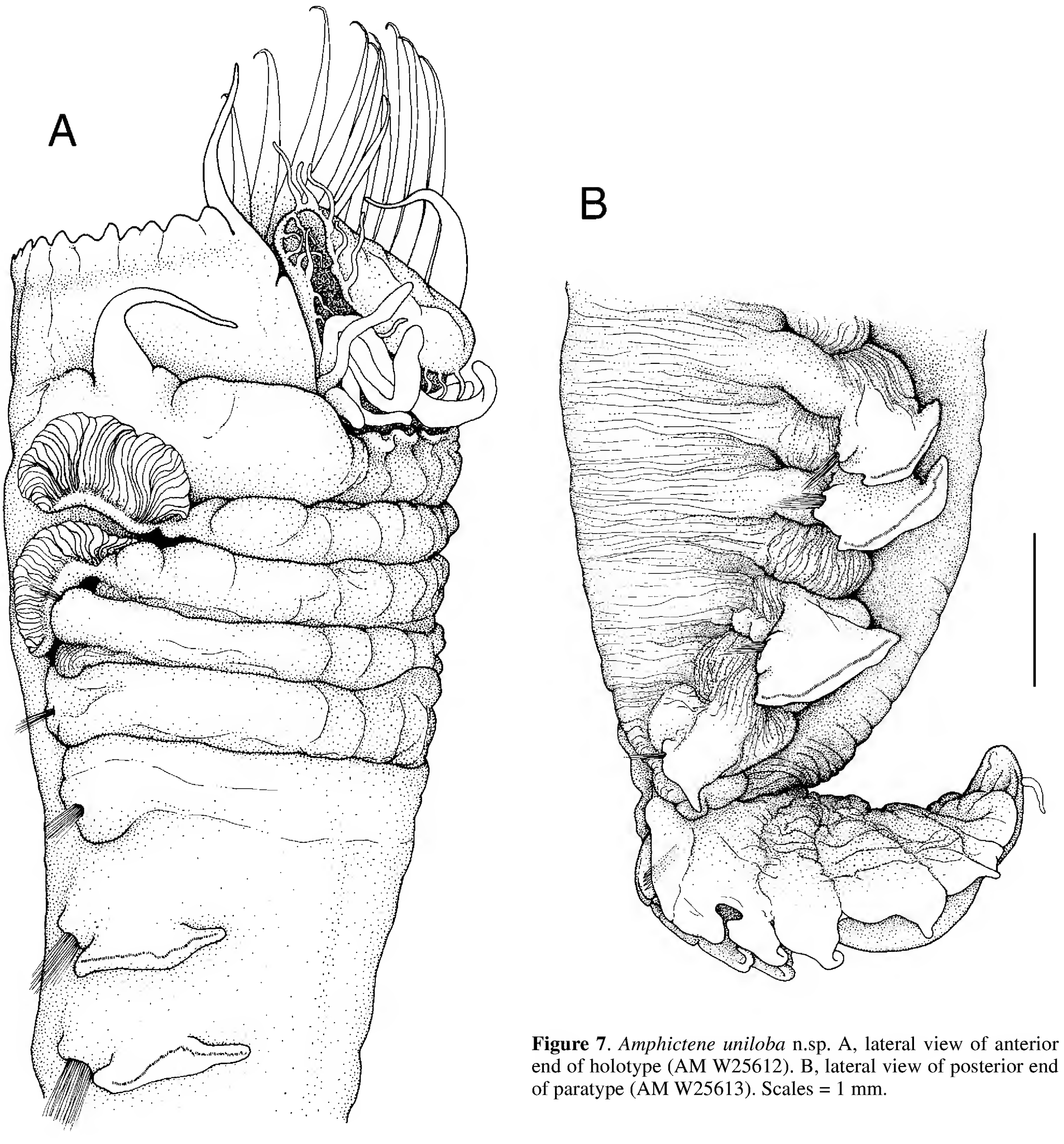


Figure 7. *Amphictene uniloba* n.sp. A, lateral view of anterior end of holotype (AM W25612). B, lateral view of posterior end of paratype (AM W25613). Scales = 1 mm.

number of cirri on the cephalic veil (11 to 21), 14 pairs of paleae and 4 to 10 pairs of scaphal hooks present (see Table 1). The species most closely resembles *A. japonica* Nilsson, 1928, in terms of the number of cirri on the cephalic veil but differs in the number of pairs of paleae present. Table 1 shows that several described species are poorly known with no indication given of the amount of variation exhibited for individual characters. This study, which examined a large amount of material, revealed that some characters such as the number of cirri on the cephalic veil, the number of pairs of cirri on the opercular rim and the number of pairs of scaphal hooks vary according to size of the individual and thus presumably with age. Future studies of the group must consider these size related variations.

Amphictene uniloba can be distinguished from the other Australian species *A. favona* by the number of cirri present on the cephalic veil. *Amphictene uniloba* has fewer cirri (11 to 21) than *A. favona*, which has 23 to 28, and the number of pairs of paleae differs, *A. uniloba* having 14 and *A. favona* having 12 pairs. Both species occur on the east coast of Australia but *A. favona* also occurs on the northwest coast (see Fig. 6).

Etymology. The specific name *uniloba* refers to the single anteroventral lobe present on chaetiger 2 and is derived from the latin word unus.

Distribution. Eastern Australia; known only from Jibbon Beach, Port Stephens, NSW and Townsville, Qld (Fig. 6).

Habitat. Intertidal to 100 m depth, no sediment data available.

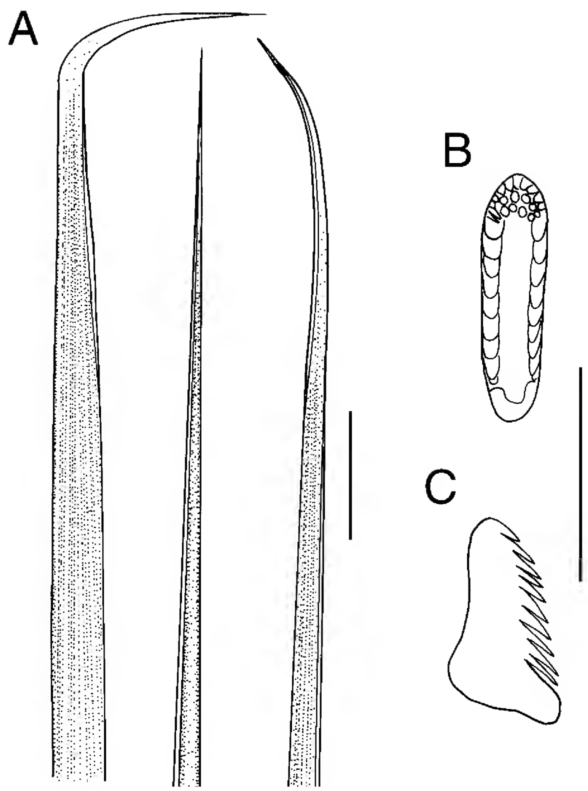


Figure 8. *Amphictene uniloba* n.sp. Holotype (AM W25612). A, three types of notochaetae from chaetiger 5, scale = 100 µm. B, frontal view of neurochaeta from 8th uncinigerous segment. C, lateral view of neurochaeta from 8th uncinigerous segment. Scale for B and C = 25 µm.

Cistenides Malmgren, 1866

Tables 2, 6

Cistenides Malmgren, 1866: 358.–Hartman, 1941: 328.–Fauchald, 1977: 120.

Diagnosis. Rim of cephalic veil with numerous long cirri. Cephalic veil completely free from operculum, forming dorsal semi-circular lobe covering bases of numerous peristomial palps. Raised opercular margin smooth. Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only, chaetigers 4 to 16 biramous with notopodia, neuropodia, notochaetae and neurochaetae, chaetiger 17 with notopodia and notochaetae only (17/13). Notochaetae all smooth capillaries. Neurochaetal uncini with major teeth arranged in one row. Posterior 5 segments fused, forming flattened plate or scaphe, distinctly separated from abdomen.

Type species. *Sabella granulata* Linnaeus, 1767, designated by Hartman (1959).

Remarks. The genus has not been recorded from Australian waters. The major diagnostic characters of the six species assigned to this genus are given in Table 2. Species have been separated using the following characters: number of cirri on the cephalic veil, and the number and shape of paleae and scaphal hooks. For several species, the characters are described from non-type material as the original species description is poor. The distinguishing generic character is the presence of a single row of teeth on the uncini. Four species previously referred to the genus *Cistenides, C. aegyptia* Savigny, 1818, *C. chilensis* Nilsson, 1928, *C. gouldii* Verrill, 1874 and *C. regalis* Verrill, 1900, have uncini with two rows of teeth according to the literature and are transferred to the genus *Pectinaria*. *Cistenides hyperborea* Malmgren, 1866, is poorly known, and the type description does not indicate the number of rows of teeth present on the uncini, although 1 to 3 rows of teeth have been recorded on other material assigned to this species. Material from the species type locality of Greenland needs to be re-examined to ascertain the generic identity of this species. Holthe (1986) suggests that no type material exists and probably was never designated. All species now recognised as belonging to the genus occur only in the Northern Hemisphere and often in cold water.

Lagis Malmgren, 1866

Tables 3, 6

Lagis Malmgren, 1866: 360.–Fauchald, 1977: 120.–Holthe, 1986: 18.

Diagnosis. Rim of cephalic veil with numerous long cirri, at least partially fused to operculum. Cephalic veil semi-circular, covering the bases of numerous peristomial palps. Raised opercular margin smooth. Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only, chaetigers 4 to 15 biramous with notopodia, notochaetae, neuropodia and neurochaetae, chaetiger 16 with notopodia and notochaetae only (16/12). Notochaetae all smooth capillaries. Neurochaetal uncini with major teeth arranged in two or more rows. Posterior 5 segments fused, forming flattened plate or scaphe, [as for *Cistenides*] and distinctly separated from the abdomen.

Type species. *Lagis koreni* Malmgren, 1866, by original designation.

Remarks. The genus has not been recorded from Australian waters, although *L. australis* (Ehlers, 1904) was described from New Zealand. We have examined material from the type locality and used this to complete the entry for this species in Table 3. The major diagnostic characters of the species assigned to this genus are given in Table 3. Currently ten species are known. Characters such as the number of cirri on the cephalic veil, numbers and types of paleae and scaphal hooks, as well as the numbers of rows of teeth on the uncini are used to distinguish species. However, as is clear from Table 3, some of these diagnostic characters exhibit ranges, which may make the separation of species difficult, although species appear to have non-overlapping geographical distributions. Five species are known only from type material. We have reassigned *Pectinaria bocki* Hessle, 1917 to this genus because the uncini have four rows of teeth.

Species of this genus have been reported from many localities around the world.

Pectinaria Savigny in Lamarck, 1818

Tables 4, 6

Pectinaria Savigny in Lamarck, 1818: 348.–Hartman, 1941: 329.–Fauchald, 1977: 120.– Hartman, 1959: 479.–Holthe, 1986: 20–21.

Diagnosis. Rim of cephalic veil with numerous long cirri. Cephalic veil completely free from operculum, forming a dorsal semi-circular lobe covering the bases of numerous peristomial palps. Raised opercular margin smooth. Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only, chaetigers 4 to 16 biramous with notopodia, neuropodia, notochaetae and neurochaetae, chaetiger 17 with notopodia and notochaetae only (17/13). Two types of notochaetae, smooth and serrated (or plumose). Neurochaetal uncini with major teeth arranged in two rows. Posterior 5 segments fused to form a flattened plate or scaphe and distinctly separated from the abdomen.

Type species. *Nereis cylindraria belgica* Pallas, 1766, designated by Hartman (1959).

Remarks. Savigny worked at the Museum d'Histoire Naturelle in Paris. He wrote a description of the genus *Pectinaria* in 1809 and completed the plates in 1812, but it was not until 1822, that the manuscript was published with no major modifications. During the intervening years, Lamarck, who also worked at the Museum in Paris and was the superior of Savigny, had access to this unpublished manuscript and he published the name *Pectinaria* in 1818. Some workers have therefore quoted the authority of the genus as Lamarck (Lucas & Holthuis, 1975) but because Savigny actually made the description, we therefore quote it as Savigny in Lamarck, 1818. Another complication is that Leach (1816) described the genus *Cistena* and referred *Nereis cylindraria* Pallas to his new genus, and Lucas & Holthuis (1975) believed that this was a reference to the var. *belgica*. *Lagis koreni* is the only common pectinariid on the west coast of Holland where Pallas worked. Lucas & Holthuis (1975) designated a lectotype of Pallas's *Nereis cylindraria belgica*. The name *koreni* Malmgren, 1866, as published in the combination *Lagis koreni*, then became a junior subjective synonym of the name *belgica* Pallas, 1766, the type species of *Pectinaria* (*Nereis cylindraria belgica*). The synonymising of *P. koreni* and *P. belgica* was objected to by Nielsen *et al.* (1977) who made a submission to the International Commission on Zoological Nomenclature to stabilise the names of *Pectinaria belgica* (Pallas, 1766) and *Pectinaria koreni* (Malmgren, 1866). They provided evidence that both names had been used by marine biologists for over 100 years, and their submission was accepted (Nielsen *et al.*, 1977). For further details, see Lucas & Holthuis (1975) and Nielsen *et al.* (1977).

Twenty species of *Pectinaria* have been described, including four species originally described as Cistenides that we have transferred to *Pectinaria*. Two additional species are described in this paper. The major diagnostic features of these species are given in Table 4. Several of these species are poorly described and, in some cases, characters states have had to be assigned from non-type material.

Table 2. Major distinguishing characters of species of *Cistenides* (entries in parentheses are based on non-type material).

species	holotype length mm	holotype anterior width mm	cephalic veil, nos. of cirri	nos. of pairs	shape of paleae	posterodorsal lobe (segment 2)	anteroventral lobe (chaetiger 2)
C. brevicoma Johnson, 1901†	(31)	(*n.r.*)	33 (28–30)	10–12 (12–13)	short, stout, iridescent	*n.r.*	glandular
C. ehlersi (Hessle, 1917)	*n.r.* (15–31)	*n.r.* (3)	25 (20–30)	12 (8–15)	*n.r.* (spiral-tipped, rolled top)	*n.r.*	corrugated (*n.r.*)
C. granulata (Linnaeus, 1767)	*n.r.* (24–65)	*n.r.* (7–8)	*n.r.* (30–50)	*n.r.* (7–10)	*n.r.* (acute, blunt tips, elongate, curved dorsally)	*n.r.*	*n.r.* (glandular)
C. hyperborea Malmgren, 1866†	23–28 (13–55)	6–10	32–34 (26–35)	12–14 (10–15)	flat, attenuated flexible tips (coiled tips)	absent	glandular
C. okudai Imajima & Hartman, 1964	18–24	3–5	10–15	13–16	distally incurved and faintly serrated	*n.r.*	glandular
C. soldatovi Annenkova, 1929	18–20	*n.r.*	20–30	10–13	curved tips	*n.r.*	glandular

† no holotype designated, rather a range from the type series.

Table 2 (continued). Major distinguishing characters of species of *Cistenides* (entries in parentheses are based on non-type material).

species	chaetigers on which notopodia reduced	nos. of rows of teeth per uncinus	nos. of teeth within a row on uncinus	scaphal shape	scaphe: anal flap	scaphal hooks: nos. of pairs & type	tube, shape & construction	glandular areas	type locality	additional records and comments*
C. brevicoma	*n.r.* (1–3, 16–17)	*n.r.* (1)	4–5 (4)	broadly ovate (broader than long)	*n.r.* (broadly rounded, entire margin with small cirrus)	*n.r.* (8–10, distally hooked)	curved, coarse sand grains	*n.r.*	Puget Sound, W. coast of USA—18.3 m	Recorded from Mexico, California, USA (Hartman, 1941).
C. ehlersi	*n.r.* (1–3)	1	3–4	rectangular, lobed margin	longer than wide with short cirrus	10 (6–10)	(slightly curved distally brown in colour)	*n.r.* (glandular)	Tierra del Fuego (Feuerland), Argentina—Puerto Harberton, Strait of Magellan	(See below) [g]
C. granulata	*n.r.* (1–3)	*n.r.* (1)	*n.r.* (3–4)	*n.r.* (wide-oval, lobed edge)	*n.r.* (wider than long with small cirrus)	*n.r.* (6–10)	curved, long coarse sand grains, dark coloured	*n.r.* (strongly glandular)	Northern Europe—type probably never designated (Holthe, 1986)	(See below) [h]
C. hyperborea†	1–3; 12–17	*n.r.* (1–3)	3 (4–6)	wide, oval (longer than broad)	*n.r.* (wider than long plus small cirrus)	*n.r.* (5–9)	slightly curved, brown (sand grains, dark brown)	glandular	Greenland and Spitzbergen—"type probably lost or never designated" (Holthe, 1986)	(See below) [i]
C. okudai	*n.r.*	*n.r.*	8–9	ellipsoidal, recurved ventrally, lobed margin	crenulate margin with cirrus	12–13	*n.r.*	*n.r.*	Japan	(See below) [j]
C. soldatovi	*n.r.*	1	4	oval, lobed margin	wide, flat, no anal papilla	5–6	curved, sand grains, brown	*n.r.*	Sea of Japan	Known only from original description.

n.r. character not recorded.
† Based on original description.
* Only a selection of records are given based on the literature to indicate distribution of species, however distributions outside the region of the type locality require verification.
[g] [*ehlersi*] Recorded from Puerto Harberton, Argentina (as *Pectinaria belgica* by Ehlers, 1901—*fide* Hessle, 1917); Puerto Harberton & Ultima Esperanza, Argentina (Nilsson, 1928); Strait of Magellan, shallow to 300 m, 485 m, Drake Passage 384–494 m (Hartman, 1966b; 1967).
[h] [*granulata*] Recorded from Arctic Sea (Hessle, 1917; Nilsson, 1928); northern USSR (Annenkova, 1929), east Greenland, Iceland, Faeroes, Finnmark, Spitzbergen (Holthe, 1986).
[i] [*hyperborea*] Recorded from Norway (Hessle, 1917); northern Arctic Seas, Northern Japan, Atlantic Ocean (Nilsson, 1928); Bering Sea, Spitzbergen, Siberia (Annenkova, 1929—this record indicates the presence of 2–3 rows of teeth on the uncini which puts this in the genus *Pectinaria*); Japan, NW Europe, North Atlantic, Arctic (Imajima & Hartman, 1964); east Greenland, Iceland, the Faeroes, Finnmark, Spitzbergen (Holthe, 1986).
[j] [*okudai*] Known only from original material collected by Okuda (1938) and recorded as *Pectinaria* sp.

Pectinaria antipoda Schmarda

Figs. 9A–B, 10A–C, 12A–B, 13, Tables 4, 6

Pectinaria antipoda Schmarda, 1861: 46.–Nilsson, 1928: 69–73.–Knox & Cameron, 1971: 34.–Stephenson *et al.*, 1974: 114 (in part).–Poore *et al.*, 1975: 30. *Not* Monro, 1931: 28.
Pectinaria (Pectinaria) cf. *antipoda*.–Hartmann-Schröder, 1979: 145–146.
Cistenides antipoda Augener, 1927: 231–234.
Pectinaria sp 1.–Hutchings *et al.*, 1993: 10.

Type material. NEOTYPE: BMNH 1886.8.20.1, 22 mm long, 7.0 & 5.5 mm wide.

Type locality. New South Wales: Port Jackson, Sydney, 33°51'S 151°16'E.

Additional material examined. WESTERN AUSTRALIA: N. end of Oyster Harbour, 35°03'S 117°50'E, 21.vii.1963, 5.5 m, mud, 1, WAM 45-96*; 0.8 km SE of Mistaken I., King George Sound, 35°03'S 117°58'E, 21.vii.1963, 31.1 m, 1, WAM 47-96*; Bremmer Bay, 34°24'S 119°25'E, 13.i.1979, 1, WAM 31-96*; Albany, 35°0'S 117°52'E, 1, MV F78899; 3.2 km NW of Bussleton Jetty, 33°39'S 115°20'E, 12.iv.1963, 21.9–23.8 m, *Posidonia* and *Cymodosa* patches and sand, 6, WAM 42-96*; Gnarup Reef, Margaret River, 33°54'S 115°50'E, 3.ix.1987, sandy rockpool, 1, WAM 39-96*; Rottnest I., Pocillopora Reef, 32°00'S 115°30'E, 14.i.1991, 3 m, 4, AM W25406*; 3.2 km WNW of Cottesloe, 31°59'S 115°45'E, 5.v.1960, 7.3 m, 1, WAM 400-75*; Dampier Archipelago, Norbill Bay, Rosemary I., 20°29'S 116°35'E, 21.v.1972, 1.8–3.6 m, 2, WAM 354-75*; Mermaid Sound, 20°38'S 116°29'E, 10.ii.1981, 1, WAM 38-96*; lagoon between Trimoville and Alpha I., 20°24'31"S 115°32'33"E, 13.viii.1993, 3–5 m, silty grey sand, 1, WAM 34-96*; Broome, 18°58'S 122°14'E, 1, HZM P16615. QUEENSLAND: Heron I., Great Barrier Reef, 23°27'S 151°55'E, 29.viii.1984, 10 m, 1, AM W200622*; Dunwich, 27°30'S 153°24'E, 28.vi.1963, 1, QM G3600*; 2.4 km S of SW Rocks, Peel I., Moreton Bay, 27°30'S 153°21'E, December 1970, sand, shell, mud, 1, QM G10400*. NEW SOUTH WALES: Port Jackson, 33°51'S 151°16'E, 2, BMNH 1886.8.20.2–3; Sydney, E of Malabar, 33°50'S 151°17'E, 29.v.1973, 83 m, 2, AM W6462*; Port Hacking, Gunamatta Bay, 34°05'S 151°10'E, October 1957, muddy sand at LWM, 5, AM W3672*; Bass Point, 34°36'S 150°54'E, 29.x.1990, 65–70 m, 1, AM W25418*; Jervis Bay, Green Point, 35°01'00"S 150°45'12"E, 18.vi.1991, 12 m, 3, AM W25424*; Jervis Bay, Plantation Point (S), 35°04'48"S 150°41'48"E, 18.vi.1991, 20 m, 1, AM W25425*; Jervis Bay, Montagu Roadstead, 35°02'12"S 150°46'00"E, 5.vi.1990, 12 m, 2, AM W25428*; Jervis Bay, Hole in the Wall, 35°07'36"S 150°44'48"E, 18.vi.1991, 12 m, 1, AM W25426*; Jervis Bay, Honeymoon Bay, 35°03'48"S 150°45'24"E, 5.vi.1989, 20 m, 1, AM W25614*, 4, AM W21203*, 2, AM W25423*, 21.ii.1991, 2, AM W25420*, 21.viii.1989, 1, AM W25421*, 27.ii.1990; Eden, 37°04'S 149°55'E, 13.ix.1914, 9.1 m, 1, HZM V-9562*. VICTORIA: Port Phillip Bay, 38°21'S 144°51'30"E, 9.xii.1971, 9 m, 1, AM W16203*; SW of Sandringham, 37°58'S 144°59'E, 19.iv.1959, 2, MV F41676*; front of Popes Eye Beacon, 38°16'S 144°42'E, 28.ii.1982, 7 m, sand, 1, MV F78892*, 1, MV F41681; 2, MV F41676; off Werribee, 38°00'00"S 144°42'54"E, 19.xi.1971, 7 m, sand, 1, MV F78908*; Port Phillip Heads, 37°58'S 144°54'E, 1, BMNH 1885.11.19.79; W Bass Strait, 11 km SSW of Cape Otway, 38°58'18"S 143°29'12"E, 8.x.1980, 68 m, sand, 2, MV F78889*; 30 km S of Cape Otway, 39°06'48"S 143°37'36"E, 23.xi.1981, 92 m, sandy coarse shell, 2, MV F78891*; 47 km E of Cape Rochon, Three Hummock I., 40°23'48"S 145°32'E, 3.xi.1980, 66 m, mud-shell-sand, 1, MV F78920; 42 km SW of Babel I., 40°13'48"S 148°39'36"E, 60 m, muddy sand, 2, MV F78928; 94 km NE of North Point, Flinders I., 38°53'42"S 147°55'12"E, 17.xi.1981, 71 m, shelly sand, 2, MV F78929*; 46 km SW of Lakes Entrance, 38°17'S 147°29'E, 31.vii.1983, 29–31 m, 2, MV F78938*;

Table 3. Major distinguishing characters of species of *Lagis* (entries in parentheses are based on non-type material).

species	holotype length mm	holotype anterior width mm	cephalic veil, nos. of cirri	nos. of pairs of paleae	shape of paleae	opercular rim, nos. of cirri	posterodorsal lobe (segment 2)	anteroventral lobe (chaetiger 2)
L. abranchiata (Fauvel, 1932)	11, 12, 17—no holotype designated	3	15–20	15	stout, slender rolled-in tip; inner—shorter	smooth	absent	smooth
L. australis (Ehlers, 1904)	9.5 (6–11)	3	20 (16–20)	10 (11–14)	needle-like, ends bend towards each other	smooth	absent	smooth or absent
L. bocki (Hessle, 1917)	27 (13–27)	*n.r.* (5)	40 (16–40)	12–15 (10–16)	curved dorsally, to a point (faintly serrated, coiled tips)	smooth, wide seam	*n.r.*	present, glandular
L. hupferi (Nilsson, 1928)	13–20	*n.r.*	8–11	13–15	wider, curved dorsally	high & thin	*n.r.*	glandular
L. koreni Malmgren, 1866	28 (14–50)	7 (5–9)	*n.r.* (13–30)	14 (8–17)	flat, acute apex (attenuated coiled tip; curved dorsally)	*n.r.* (smooth)	*n.r.* (absent)	*n.r.* (glandular; cirrate 8–10 lobed)
L. koreni cirrata (Day, 1963)	10	*n.r.*	14	10	curved dorsally	smooth & high	*n.r.*	absent
L. neapolitana (Claparède, 1868)	12–30 (25–32)	5–7 (9)	(12–25)	7–14 (7–12)	(curved dorsally, fine tip)	*n.r.* (smooth)	*n.r.* (absent)	glandular
L. pseudokoreni (Day, 1955)	16	4	10	11	golden-coloured	smooth	*n.r.*	glandular and ridged
L. tenera Hartmann-Schröder, 1959	2.5	*n.r.*	8–10	11	long, narrow, acute tip	smooth	absent	glandular

Table 3 (continued). Major distinguishing characters of species of *Lagis* (entries in parentheses are based on non-type material).

species	chaetigers on which notopodia reduced	nos. of rows of teeth per uncinus	nos. of teeth within a row on uncinus	scaphal shape	scaphe: anal flap	scaphal hooks: nos. of pairs & type	tube, shape & construction	glandular areas	type locality	additional records and comments*
L. abranchiata	1–3	4–5	6 (6–8?)	short, stout, erect edges bearing short ovate knobs	triangular, smooth edged, with small cirrus	10–12; short, stout, curved	straight, transparent quartz, very brittle, yellowish cement	absent on segment 4	Cochin, Ernakulam, India	(See below) [k]
L. australis	*n.r.*	3 (2–3)	4 (4–5)	longer than broad, lobed edges (oval)	poorly developed, with small cirrus	8	cone-shaped, sand grains	*n.r.* (strongly glandular)	Lyttelton, South Island, New Zealand	(See below) [l]
L. bocki	*n.r.*	4	7	oval, long, crenulated (recurved ventrally, crenulated)	longer than wide with long cirri (18–20 fimbriae plus small cirrus)	4 (3–4), claw-hook like	*n.r.* (sand grains)	*n.r.* (strongly glandular)	Kobe Bay, Japan, 14 m	(See below) [m]
L. hupferi	*n.r.*	3	5–6	wide oval, crenulate/lobed margin	crenulate margin, semi-circular, lacking anal cirrus	7	curved, sand grains	strongly glandular	Cameroon, SW coast of Africa	Known only from original description. Notochaetae with finely serrated tips.
L koreni	*n.r.* (1–3)	*n.r.* (3–4)	*n.r.* (6–8)	*n.r.* (long oval, lobed margins)	*n.r.* (longer than broad with small cirrus)	*n.r.* (2–7)	slightly curved (sand)	*n.r.* (strongly glandular)	Stavanger, Finnmark, Norway—Lectotype assigned by Nielsen *et al.* (1977)	(See below) [n]
L. koreni cirrata	1–3	2	6–7	oval, lobed margin	tongue shaped with small anal cirrus	4–6	coarse sand grains	*n.r.*	off Natal, South Africa	Known only from original description, based on single specimen.
L. neapolitana	(1–3)	*n.r.* (2–3)	7–8 (5–8)	wide oval with lobed margin	semi-circular with small cirrus	6 (4–8)	*n.r.* (curved, irregular grains)	*n.r.* (strongly glandular)	Gulf of Naples, Mediterranean	(See below) [o]
L. pseudokoreni	1–3	2–3	6–8	long oval with crenulated margin	triangular with small anal cirrus	5	sand	*n.r.*	Knysna Estuary, South Africa	Known only from original description, based on single specimen.
L. tenera	1–3	3–4	7	long oval, lobed margins	semi-circular with large anal cirrus	3	*n.r.*	strongly glandular	La Herradura, Estero Jaltepeque, El Salvador	Known only from original description, based on single specimen.

n.r. character not recorded.
* Only a selection of records are given based on the literature to indicate distribution of species, however distributions outside the region of the type locality require verification.
k [*abranchiata*] Re-recorded from India (Fauvel, 1953). Notochaetae narrow winged some straight with spinous tips. Characterised by absence of branchiae.
l [*australis*] Additional records from New Zealand (Augener, 1926). (Redescribed by Nilsson, 1928). (Examined material from type locality). Notochaetae with finely serrated tips.
m [*bocki*] Recorded by Nilsson, 1928 & Imajima & Hartman (1964) Annenkova (1929) described a variety of this species.
n [*koreni*] Recorded from Bering Sea (Annenkova, 1929); Swedish west coast (Hessle, 1917; Nilsson, 1928); North Sea, English Channel, Atlantic Ocean, Mediterranean, Adriatic (Fauvel, 1927; Holthe, 1986).
o [*neapolitana*] Records: Mediterranean Sea (Hessle, 1917; Nilsson, 1928); Black Sea (Annenkova, 1929); southwest Africa (Day, 1967).

Table 4. Major distinguishing characters of species of *Pectinaria* (entries in parentheses are based on non-type material)

species	holotype length mm	holotype anterior width mm	cephalic veil, nos. of cirri	nos. of pairs of paleae	shape of paleae	opercular rim, nos. of cirri	posterodorsal lobe (segment 2)	anteroventral lobe (chaetiger 2)
P. aegyptia (Savigny, 1818)	(70, 65)	(17, 15)	(65, 60)	(16–17, 15)	(narrow, elongate, curved spiral-form tip)	(*n.r.*)	(*n.r.*)	(present?)
P. antipoda Schmarda, 1861	22 (7–74)	5 (2–12)	present (17–29)	8 (5–6; 10–13)	subacute–acute (curved dorsally)	*n.r.* (smooth, well developed)	*n.r.* (absent)	*n.r.* (present, 12–19 cirri)
P. belgica (Pallas, 1766)	(30–70)	(9–12.5)	(17–28)	(8–15)	(attenuated,	(wide and smooth)	(absent)	(glandular)
sensu Malmgren, 1866					spiral-form tip)			
P. brevispinis Grube, 1878	92 (60–90)	10 (12–17)	25–30 (22–24)	12–13 (10)	*n.r.* (short, subacute)	smooth (a little wrinkled)	absent	absent (slightly glandular)
P. californiensis Hartman, 1941	19	*n.r.*	18–30	*n.r.*	flattened, tapering to fine attenuate, recurved tips	*n.r.*	*n.r.*	*n.r.*
P. c. newportensis Hartman, 1941	*n.r.*	*n.r.*	19	9–13	slender, flattened, fine coiled tips	*n.r.*	*n.r.*	*n.r.*
P. clava Grube, 1878	17	6.5	10 (10–12)	11	acute, curved	smooth (wrinkled)	absent	*n.r.* (absent)
P. chilensis (Nilsson, 1928)	60 (46)	12 (15)	60 (30–60)	8–9 (9–10)	wide (elongate, attenuate)	smooth, low rim	*n.r.*	glandular?
P. conchilega Grube, 1878	32	5.5	12	11	acute curved	smooth	absent	*n.r.*
P. dimai Zachs, 1933	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*
P. dodeka n.sp.	17 (8–80)	4 (18)	16 (16–28)	12 (11–13)	subacute, curved dorsally	smooth, well developed	absent	smooth, glandular
P. gouldii (Verrill, 1874)	40 (12–45)	7 (1–9)	28 (12–38)	15 (9–15)	curved upward, long slender, acute tip (tapering to fine, slightly curved tips)	smooth	*n.r.*	*n.r.* (glandular)
P. hartmanae Reish, 1968	15–20	3–4	30	8–10	flattened, recurved, attenuated tips	*n.r.*	*n.r.*	*n.r.*
P. kanabinos n.sp.	14 (10–24)	3 (1–5)	15 (10–16)	14 (12)	acute, needle-like	smooth, well developed	absent	smooth, glandular
P. longispinis Grube, 1878	18.5	2	17	13	curled tips	smooth	absent	*n.r.*
P. meredithi Long, 1973	26 (9–26)	4 (2–4)	21 (16–21)	10 (8–11)	fine, slightly curved tips	smooth	*n.r.*	glandular
P. nana Wesenberg-Lund, 1949	5	*n.r.*	8	11	broad flat, evenly tapering	smooth	absent	smooth, reduced
P. panava Willey, 1905	*n.r.*	*n.r.*	32	10	*n.r.*	*n.r.*	*n.r.*	glandular
P. papillosa Caullery, 1944	*n.r.* (60)	*n.r.* (16–20)	24 (46)	11 (13)	fine tips	smooth	*n.r.* (absent)	glandular (cirrate)
P. parvibranchis Grube, 1878	13.8 (14)	1.8 (4)	12–13	10–11	curved, acute tips	smooth	absent	*n.r.*
P. profunda Caullery, 1944	*n.r.*	*n.r.*	20	12	fine tip, flexible and recurved	smooth	*n.r.*	glandular
P. regalis (Verrill, 1901)	95 (26–90)	12–13 (6–17)	(21–35)	11–13 (8–14)	acute (stout, slightly curved tips)	smooth	absent	cirrate (glandular)

Table 4 (continued). Major distinguishing characters of species of *Pectinaria* (entries in parentheses are based on non-type material)

species	chaetigers on which notopodia reduced	no. of rows of teeth per uncinus	no. of teeth within a row on uncinus	scaphal shape	scaphe: anal flap	scaphal hooks: nos. of pairs & type	tube, shape & construction	glandular areas	type locality	additional records and comments*
P. aegyptia	(*n.r.*)	(2)	(8, 7–8)	(oval, with 4 large lobes)	(strongly grooved edges, with poorly developed cirrus)	(4–5, stout with strongly curved tips)	(straight sided, wide, fragments)	(triangular lobe present, a number of patches, strongly glandular)	Gulf of Suez?	(See next page) [p]
P. antipoda	1–3 (15–17)	*n.r.* (2–4)	8 (6–10)	diamond shaped (oval shaped, as long as wide, lobed edges)	*n.r.* (triangular, with small anal cirrus)	*n.r.* (6–8)	clear grains, clear cement (pale grains of shell)	*n.r.* (strongly glandular)	Port Jackson, Australia. Type lost, neotype designated this paper.	(See next page) [q]
P. belgica	1–3	2–3–4	7–8	oval, long, crenulated edges	small; wider than long, with short cirrus	6–12	straight, sand grains, brown	strongly glandular	Bohuslan, Sweden. Neotype designated by Nielsen et al., (1977) from Malmgren's material.	(See next page) [r]
P. brevispinis	1–3	*n.r.* (2)	9 (7–9)	oval, crenulated (broader than wide)	reduced	10 (8–12), 14 long, with pointed tips	curved (long & wide)	glandular	Philippines	Recorded from Philippines (Nils--son, 1927); Indonesia (Caullery, 1944).
P. californiensis	1–3	2	5	as long as broad, crenulated margin	wide as long with small cirrus	13	reddish sand grains	*n.r.*	Southern California, intertidal, USA	Hartman (1941) records species widely from S. California, USA.
P. c. newportensis	1–3	2	5	as long as broad, crenulated margins	margins with 16 clavate papillae with large cirrus	10–12	sand grains	strongly glandular	Newport Bay, California, USA	(See next page) [s]
P. chilensis	1–3	2	7–8	longer than wide, lobed edges	long with anal cirrus (crenulate margin)	15 (13–15)	*n.r.* (straight, greyish)	strongly glandular	Coronel, Chile	Recorded from Independencia Bay, Peru (Hartman, 1941).
P. clava	*n.r.*	*n.r.* (3)	6–7 (5–6)	oval, long	*n.r.*	6	fragile, dark	*n.r.*	Lapinig Canal,Philippines	Recorded from by Nilsson, 1928 (Philippines).
P. conchilega	1–3	*n.r.* (3–4)	6–7 (5–6)	short, sub-oval, lobed (wide oval, lobed edges)	small (crenulate margin, no anal cirrus)	*n.r.* (4)	(curved, sand grains)	*n.r.*	Bohol, Philippines	Recorded from Philippines by Nilsson (1928) who re-examined type material.
P. dimai	*n.r.*	3–4	6–7	*n.r.*	*n.r.*	*n.r.*	*n.r.*	*n.r.*	North Japan Sea	Known only from original record; original description poor.
P. dodeka n.sp.	1–3, 15–17	2–4	6–10	broader than long, lobed crenulated margin	present	8 (6–10) broad, blunt, brown	pale grains of sand, and shell	strongly glandular	Dunwich, Moreton Bay, Queensland, Australia	See Fig. 10 for distribution.
P. gouldii	*n.r.* (1–3, 16)	*n.r.* (2–4)	*n.r.* (6–8)	*n.r.* (wide, oval, lobed margins)	*n.r.* (semi-circular with small cirrus)	17–22 (8–16, size dependent)	*n.r.* (clear grains, curved; tapered)	*n.r.* (strongly glandular)	syntype from Long Island Sound USA (*fide* Long, 1973)	(See next page) [u]
P. hartmanae	1–3	2	7	*n.r.*	crenulated margin, medial cirrus	8–10, blunt, brassy	straight, coarse silicious grains	*n.r.*	Bahia de los Angeles, Baja California, USA	Known only from type series.
P. kanabinos n.sp	1–3, 15–17	2–4	6–10	longer than broad, crenulated margin	damaged	5 (4–6) fine, small,	*n.r.*	Weakly glandular	Calliope River Gladstone, Queensland, Australia	See Fig. 10 for distribution.
P. longispinis	*n.r.*	*n.r.*	7	rounded quadrate	*n.r.*	4	granular	*n.r.*	Philippines	Known only from original record.
P. meredithi	1–3, 16	2–3	6–8	long oval, lobed margins	semi-circular with small cirrus	8 (7–9)	slightly curved, 2 layers	*n.r.*	Bahamas	Recorded from Florida Keys, USA (Long, 1973).
P. nana	1–3	*n.r.*	*n.r.*	oval with highly lobed margins	longer than wide with long anal cirrus	3	straight, silicious grains	*n.r.*	Gulf of Oman, Iran	Known only from a single specimen.
P. panava	1–3	*n.r.*	8	acetabuliform	semi-lunar	7	*n.r.*	*n.r.*	Sri Lanka	"The characters given are not even sufficient for generic identification" (Fauvel, 1953).
P. papillosa	1–3, 17	2	9 (7–8)	oval, lobed margins, papillose surface	ligule triangular without anal cirrus	11 (3–4)	brown, forams (sand grains)	*n.r.*	Indonesia (5°28'S 134°53'E) 47 m.	Recorded from Inhaca Island, Dela-goa Bay, Mozambique (Day, 1951).
P. parvibranchis	*n.r.*	*n.r.* (3–4)	7 (6)	trapezoidal	*n.r.*	4	curved	*n.r.*	Pangloo, Philippines	Redescribed by Nilsson (1928) from the Philippines.
P. profunda	1–3, 17	2	6	lobed margins, wide oval	triangular with small cirrus	present but not counted	*n.r.*	*n.r.*	Indonesia (5°40'S 132°26'E)	Known only from two individuals.
P. regalis	1–3, 16	*n.r.* (2–3)	*n.r.* (6–10)	semi-circular, lobed margin	*n.r.*	*n.r.* (1–4)	curved, pale, sand (blunt, shell, forams)	*n.r.*	Cony Island, Bermuda	(See next page) [v]

Table 4 (footnotes).

n.r. character not recorded.
* Only a selection of records are given based on the literature to indicate distribution of species, however distributions outside the region of the type locality require verification.
[p] [*aegyptia*] Recorded from Red Sea, Mozambique, Japan? (Nilsson, 1928; Imajima & Hartman, 1964; Marenzeller, 1879; Grube, 1870; Gravier, 1906).
[q] [*antipoda*] Recorded from New Zealand (Ehlers, 1904), SE Australia (Nilsson, 1927; Augener, 1927); Gulf of Oman (Wesenberg-Lund, 1949); Persian Gulf (Fauvel, 1953); Broome, WA (Hartmann-Schröder, 1979). Non-Australian material needs checking.
[r] [*belgica*] Recorded from: Swedish west coast (Hessle, 1917); North Sea; Irish Sea; Atlantic Coast of West Ireland (Fauvel, 1927); Boreal Atlantic Ocean (Nilsson, 1927); North Sea, Scandinavia (Holthe, 1986).
[s] [*californiensis newportensis*] Known only from original record, differs from stem species in shape and colour of paleae and shape of scaphal hooks.
[u] [*gouldii*] Recorded as *P. belgica* on East coast of USA and West Indies (Gould, 1841; Nilsson, 1928; Long, 1973).
[v] [*regalis*] Recorded from Bermuda, Puerto Rico, Virgin Islands, Barbados, Florida, Bonaire, Georgia (Long, 1973).

Bennison Channel, 1 km S of Granite I., 38°49'S 146°23'E, 23.xi.1983, 6 m, sand, shell, grit, 1, MV F78901*. Tasmania: Midway Point, 42°48'S 147°32'E, 9.xii.1973, 1, TMAG K937*; Tasman Peninsula, Fortescue Bay, 43°08'S 147°57'E, 7.vi.1977, 10 m, sand, 1, TMAG K935*; Tasman Peninsula, Koonya, 43°04'S 147°49'E, 26.v.1974, muddy sand, 1, TMAG K432*; Tinderbox, 43°04'S 147°20'E, 18.iii.99, 8 m, 1, AM W26160*; North East River, 39°45'S 147°56'E, 8.iv.97, low water mark, 1, AM W26161*; Dennes Point, 43°05'S 147°21'E, 28.iii.99, 5 m, 2, AM W26162*; Creeses Mistake, 43°07'S 147°47'E, 30.iv.99, 15.5 m, 3, AM W26163*; Simmonds Point, 43°12'S 147°17'E, 29.i.99, 17.9 m, 2, AM W26164*. SOUTH AUSTRALIA: Nuyts Archipelago, Franklin I., N of West I., 32°27'S 133°40'E, 14.iv.1983, 6–8 m, sandy seagrass beds, 1, SAM E3042*; Sir Joseph Banks Group, W side of Kirkby I., 34°33'S 136°13'E, 31.i.1986, 3–10.7 m, reef rubble, sand and *Posidonia*, 8, SAM E3076*; E of Lusby Rocks, between Lusby and Partney I., 34°32'S 136°15'30"E, 24.i.1986, 3–4.6 m, reef, rubble, sand and *Posidonia*, 3, SAM E3088*; cove at S end of Reevesby I., 34°32'S 136°17'E, 24.i.1986, 3–6.1 m, reef, deep crevices and sand pockets, 1, SAM E3086*; Kangaroo I., Bay of Shoals, 35°50'S 137°15'E, March 1978, 33 m, 1, AM W25409*; Kangaroo I., N side of Point Ellen, 36°00'S 137°11'E, 26.i.1989, 2.4–7.6 m, sand, 1, SAM E3087*; Yorke Peninsula, Wool Bay Jetty, 35°00'S 137°46'E, 3.i.1994, 3 m, sand, 3, SAM E3083*; Spencer Gulf, Yorke Peninsula, Point Turton Jetty, 34°56'S 137°21'E, 25.xi.1985, 3–4.6 m, sand and rubble, 1, SAM E3035*; Eyre Peninsula, Fancy Point, Boston I., 34°39'S 136°54'E, 17.ii.1988, 1.5–8 m, in amongst kelp, *Posidonia* seagrass, sand, 1, SAM E3077*; Edithburgh, 35°05'S 137°45'E, 27.x.1980, 3 m, in sand amongst rocks, 1, SAM E3089*; Spencer Gulf, 16 km SW of First Creek, Port Pirie, 33°16'S 137°51'E, 1979, 12.1 m, 1, AM W25410; Monument Hill, 32°50'S 137°49'E, September 1987, 17 m, 1, SAM E3066*; Whyalla, 33°05'S 137°37'38"E, August 1986, 12 m, sand, 1, SAM E3050*; Victor Harbour, the Bluff, 35°33'S 138°38'E, 8.xi.1980, under sand on rock, 1, SAM E3092*; Cape Jervis Jetty, 35°36'S 138°06'E, 9.iii.1984, 3 m, sand in amongst rocks, 1, SAM E3081*; N of St. Francis I., 32°31'S 133°18'E, 30.xii.1975, 20–30 m, 1, MV F78893*. Material examined 7 to 74 mm long & 2 to 12 and 1 to 6 mm wide. A selection of material examined listed, although all material examined has been incorporated into Fig. 13, illustrating the distribution and abundance of the species.

Material described. Neotype.

Description. Preserved specimen grey to pale cream in colour. Body small, conical in shape. Tube curved, composed of cemented shell-like fragments, or composed of sand grains. Rim of cephalic veil with 17 long cirri. Cirri are triangular appendages, which rapidly taper (Fig. 9A). Cephalic veil completely free from operculum, forming a dorsal semi-circle around the numerous buccal antennae.

Raised opercular margin well developed, smooth. Operculum with 10 pairs of paleae, yellow-gold, subacute, curved dorsally, long without extended tips. First pair of tentacular cirri arise from anterior edge of segment 2. Ventral ridge connecting second pair of tentacular cirri on segment 3 incised to form glandular lobes. Segment 2 lacking posterodorsal lobe. Chaetiger 2 with anteroventral lobe large and broad; anterior margin of lobe with 13 contiguous rounded papillae.

Two pairs of comb-like, stalked branchiae on segments 3 and 4, situated laterally and consisting of loose flat lamellae. Anterior pair situated more ventrally than posterior pair, both pairs similar in size, lying flattened against the body.

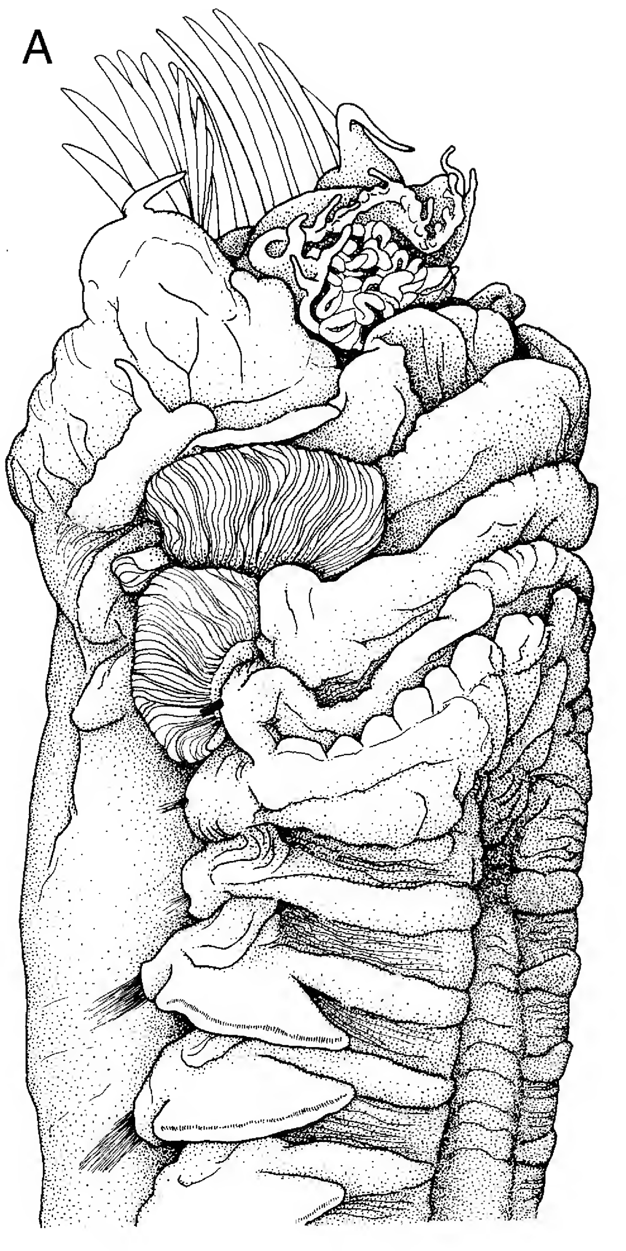
Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only. Chaetigers 4 to 16 biramous with both notopodia, neuropodia, and notochaetae and neurochaetae. Chaetiger 17 with only notopodia and notochaetae. Notochaetae from chaetiger 5 include smooth winged capillaries, and capillaries with finely serrated margins (Figs. 10A). Notochaetae from chaetiger 14 with finely hirsute surfaces. Notochaetae of chaetigers 1–3 and 15–17 reduced in size compared to those of notopodia 4–14. Neuropodia wedge shaped, erect and glandular. Neurochaetae with major teeth arranged in two rows, 6–10 teeth per row (Figs. 10B,C, 12A).

Posterior scaphe and abdomen distinctly separated. Posterior 5 segments fused to form a flattened plate or scaphe longer than broad, with crenulated margins (Fig. 9B). Anal flap present with dorsal papilla. Scaphal hooks present, 7 pairs, broad, blunt, brown (Fig. 12B). Glandular areas present on chaetigers 4 to 17, prominent, ventrally glandular on segments 1–6.

Nephridial papillae present on segments 3 and 4, inserted ventrally at base of branchiae.

Variation. The number of cirri on the cephalic veil margin varies from 19 to 29, and the number of papillae on the anteroventral lobe of chaetiger 2 ranges from 12 to 19. The size of the anterior pair of branchiae varies such that on some specimens they are larger than the posterior pair. The number of scaphal hooks varies from 6 to 8 pairs. The development of the glandular areas varies between specimens. Most of these variations appear to be size dependent, with larger animals having more cirri, papillae and pairs of scaphal hooks than smaller individuals.

Remarks. Schmarda's type of *P. antipoda* could not be located. Most of Schmarda's material is housed in the Naturhistorisches Museum in Vienna. Dr Helmut Sattmann, the Curator of polychaetes at this Museum, confirmed that no material of *P. antipoda* was present in their collections. The species has been reported from Australia several times since it was described in 1861, by Augener (1927), Knox & Cameron (1971) and Poore *et al.* (1975). All this material has been examined and represents *P. antipoda*. Nilsson



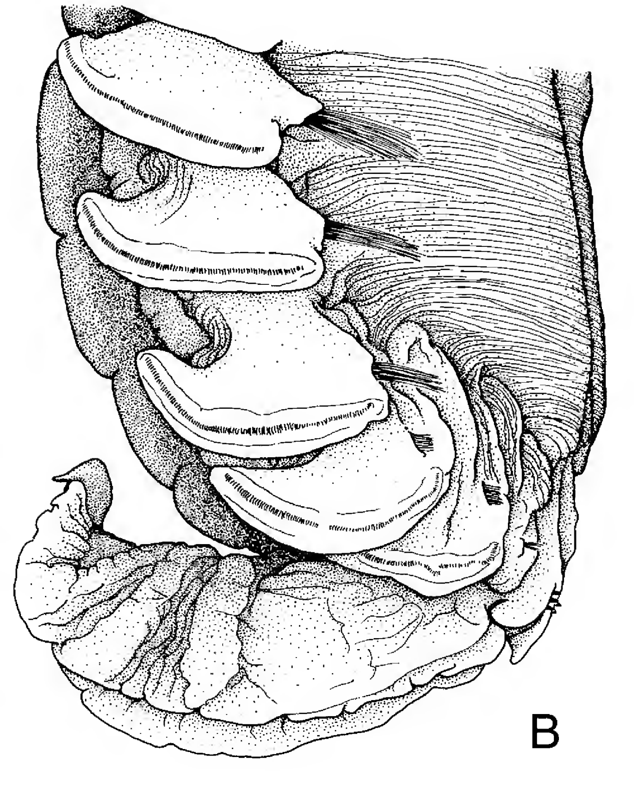


Figure 9. *Pectinaria antipoda* (Schmarda, 1861). Neotype (BMNH 1886.8.20.1). A, lateral view of anterior end. B, lateral view of posterior end. Scales = 2 mm.

(1928) also described the species and examined some material from Port Phillip Bay housed in the Zoologisches Museum, Museum für Naturkunde der Humboldt-Universität, Berlin. According to Dr Neuhaus, the Curator responsible for polychaetes, the material has been lost, perhaps destroyed during the Second World War. As *P. antipoda* is widely distributed throughout Australian waters, the species needed to be fully described because the original description is brief. Three specimens of *Pectinaria antipoda* were found in the Natural History Museum in London. They were collected by Dr Robert von Lendenfeld, an Austrian sponge worker who visited Australia in the 1880s, and although he established a laboratory in Melbourne on the shores of Port Phillip Bay, he also travelled to Sydney. These three specimens were collected from Port Jackson several decades after Schmarda's material was collected, although no detailed location within the harbour is given. During this period, little development occurred within the harbour, so we have assumed that environmental conditions were similar to those at the time Schmarda's material was collected. Another species of this genus, *Pectinaria dodeka* n.sp. (described in this paper), is also present in Sydney Harbour, but the material of Lendenfeld most closely resembles Augener's material and that described by Nilsson and the brief description given by Schmarda (1861). To stabilise the name, we have designated a neotype of *Pectinaria antipoda* from among these three specimens, provided a full description and re-illustrated the species.

The distribution of the two species of *Pectinaria* in Sydney Harbour is not known. The harbour has a variety of habitats and the two species were never present in the same samples examined by us.

Pectinaria antipoda can be distinguished from the other two species of *Pectinaria* present in Australian waters, *P. dodeka* n.sp. and *P. kanabinos* n.sp., both described in this paper, by the presence on the anteroventral lobe of chaetiger 2, ornamented with 12–19 papillae, which are absent in the other two Australian species. Only one other described species of *Pectinaria, P. papillosa* Caullery, 1944, has such papillae (Table 4).

Material identified by Monro (1931) from Low Islands, Great Barrier Reef (BMNH 1931.7.1.61) as *P. antipoda* Schmarda, 1861, was re-examined and identified as *P. dodeka* n.sp. (this paper). Material identified as *P. antipoda* by Stephenson *et al.* (1974) from Moreton Bay was re-examined and consisted of both *P. antipoda* and *P. dodeka* n.sp. Material identified by Hartmann-Schröder (1979) as *P.* cf. *antipoda* has been re-examined and although the material is in poor condition, especially in the region of

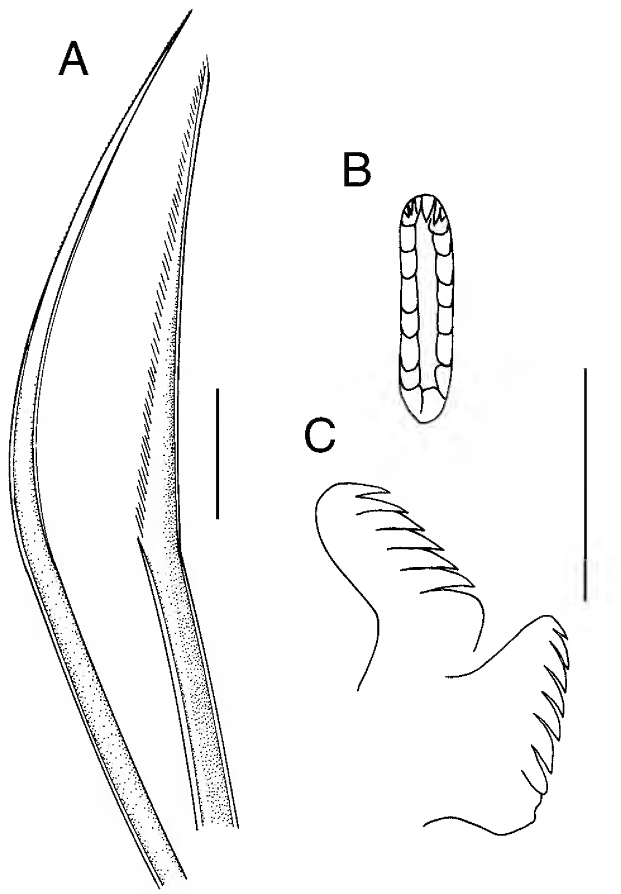


Figure 10. *Pectinaria antipoda* (Schmarda, 1861). Neotype (BMNH 1886.8.20.1). A, two types of notochaetae from chaetiger 5. B, frontal view of neurochaeta from 6th uncinigerous segment. C, lateral view of two neurochaetae from 6th uncinigerous segment. Scales = 100 µm.

chaetiger 2, we believe that it is *P. antipoda*.

Distribution. Widely distributed south from Broome, Western Australia around southern Australia and along the eastern coast to Heron Island, Queensland (Fig. 13).

Habitat. Recorded from low water mark to 92 m, in sediments ranging from mud, silty sand to sand, and occasionally in *Posidonia* seagrass beds.

Pectinaria dodeka n.sp.

Figs. 11A–B, 12C–D, 13, 14A–B, 15A–C, Tables 4, 6

Pectinaria brevispinis.–Nilsson, 1928: 64–68.–Monro, 1931: 27–28.–Caullery, 1944: 71. *Not* Grube, 1878.
Pectinaria antipoda.–Stephenson *et al*., 1974: 114 (in part). *Not* Schmarda, 1861.

Type material. HOLOTYPE: 1, AM W25615*, 27.iii.1962, 17 mm long, 4 & 2 mm wide. PARATYPE: 1, AM W19076*, 21 mm long, 4 & 2 mm wide.

Type locality. Queensland: Moreton Bay, Dunwich, 27°30'S 153°24'E, collected 27.iii.1962, no information on habitat available.

Additional material examined. NORTHERN TERRITORY: Darwin Harbour, 12°27'S 130°48'E, 6.vii.1993, 17 m, 1, NTM W10399*; Gulf of Carpentaria, Bing Bong, McArthur River, 15°37'S 136°15'E, 2, NTM W7720*; 1, NTM W16862*; 1, NTM W16864*. QUEENSLAND: Torres Strait, Murray I., 09°33'S 144°03'E, 1, AM W2648*; Low Isles, Great Barrier Reef, 16°23'S 145°34'E, ii.1929, 1, BMNH 1931.7.1.60, ii.1929, 1, BMNH 1931.7.1.61, February 1929; 1, AM W2615*; off South Mission Beach, Dunk I., 17°57'S 146°09'E, ii.1910, 1, AM W100*; Whitsunday Group, 20°03'S 148°53'E, i.1933, 1, AM W3028; Lindeman I., 20°27'S 149°02'E, 1935, 1, AM W25446*, in sand*, i.1928, 16 m, 1, AM W2649*; Hayman I., Whitsunday Pass, 20°03'S 148°53'E, i.1934, 1, AM W3117*; Langford Reef, Black I., 20°05'S 148°54'E, xi.1969, 1, AM W4292; Calliope River, N of Gladstone, 24°01'S 150°59'E, 1974, 4, AM W199312*; Moreton Bay, Dunwich, 27°25'S 153°20'E, 1967, 1, QM G5042*; Stradbroke I., Dunwich, 27°30'S 153°24'E, 4.x.1952, 1, QM G4080*; 2.4 km S of South West Rocks, Peel I., 27°30'S 153°21'E, vi.1970, 3.4 m, sand, mud, shell, 1, QM G10340*; Brisbane River mouth, 27°22'S 153°11'E, 22.vii.1975, sand and mud, 3, QM GH2880*; Middle Banks, 27°13'S 153°19'E, viii 1982, 4, QM G212177*; 1.6 km SE of Redcliffe Jetty, 27°15'S 153°08'E, 15.xii.1964, 4.2 m, shell, grit, 1, QM G5040*; Bramble Bay, 27°18'S 153°06'E, 29.vi.1972, 4, QM G10515; viii.1972, 2, QM G10635*; NEW SOUTH WALES: Lake Macquarie, 36°54'S 149°53'E, vi.1977, *Zostera* beds, 2, AM W17847*; Sydney, Port Jackson, 33°50'S 151°16'E, xi.1925, 1, AM W1760*; between Sow & Pigs Shoal and Shark I., 30°52'S 153°00'E, iv.1928, 4–5 m, 1, AM W2578*; 1 km SE of Little Bay, Malabar, 33°59'09"S 151°15'40.2"E, 12.v.1972, 25 m, 1, AM W6460*; SE of Malabar, 33°58'7.8"S 151°16'52.2"E, 2.i.1973, 49–53 m, 1, AM W6461*; Jervis Bay, 35°03'S 150°44'E, 23.iv.1973, 15 m, sand, 1, AM W5617*; Merimbula Channel, 36°55'S 149°55'E, 4.xii.1975, *Posidonia*, on south side of seaward end of central sand bank, 1, AM W17111*; Lake Merimbula, 36°03'S 151°36'30"E, 25.xi.1977, 6 m, mud, 1, AM W19254*; 900 m SW of Narooma Bridge, Wagonga, 36°13'42"S 150°07'30"E, weed beds, 1, AM W10498*. VICTORIA: central Bass Strait, 35 km NNE of Cape Wickham, 39°16'00"S 144°05'24"E, 23.xi.1981, 82 m, sandy shell, 2, MV F78890*. Material examined varied from 8 to 80 mm long & 2 to18 & 1 to 8 mm wide.

Description. Preserved specimen small, conical-shaped, grey to pale cream in colour, and some black pigmentation present anteriorly. Tube curved, composed of cemented shell-like fragments.

Rim of cephalic veil with 16 long cirri tapering to blunt tip. Cephalic veil completely free from operculum forming dorsal semi-circle around numerous peristomial palps.

Raised opercular margin well developed and smooth. Operculum with 12 pairs of paleae, long, golden brown, subacute, curved dorsally, with compact tips. First pair of tentacular cirri arising from anterior edge of segment 2. Ventral ridge connecting second pair of tentacular cirri on segment 3 incised, forming glandular lobes. Chaetiger 2 with anteroventral lobe large and broad; anterior margin of lobe crenulate, posterodorsal lobe absent (Fig. 14A).

Two pairs of comb-like stalked branchiae, consisting of loose, flat lamellae. Anterior pair situated more ventrally than posterior pair and larger than posterior pair. Branchiae lie flattened against body on preserved animals.

Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only. Chaetigers 4 to 16 with notopodia, neuropodia, notochaetae and neurochaetae. Chaetiger 17 with notopodia and notochaetae only. Notochaetae capillaries with one margin strongly pectinated (Figs. 11A–B, 15A). Notopodia and notochaetae of chaetigers 1 to 3 and 15 to 18 are slightly reduced in size in comparison to

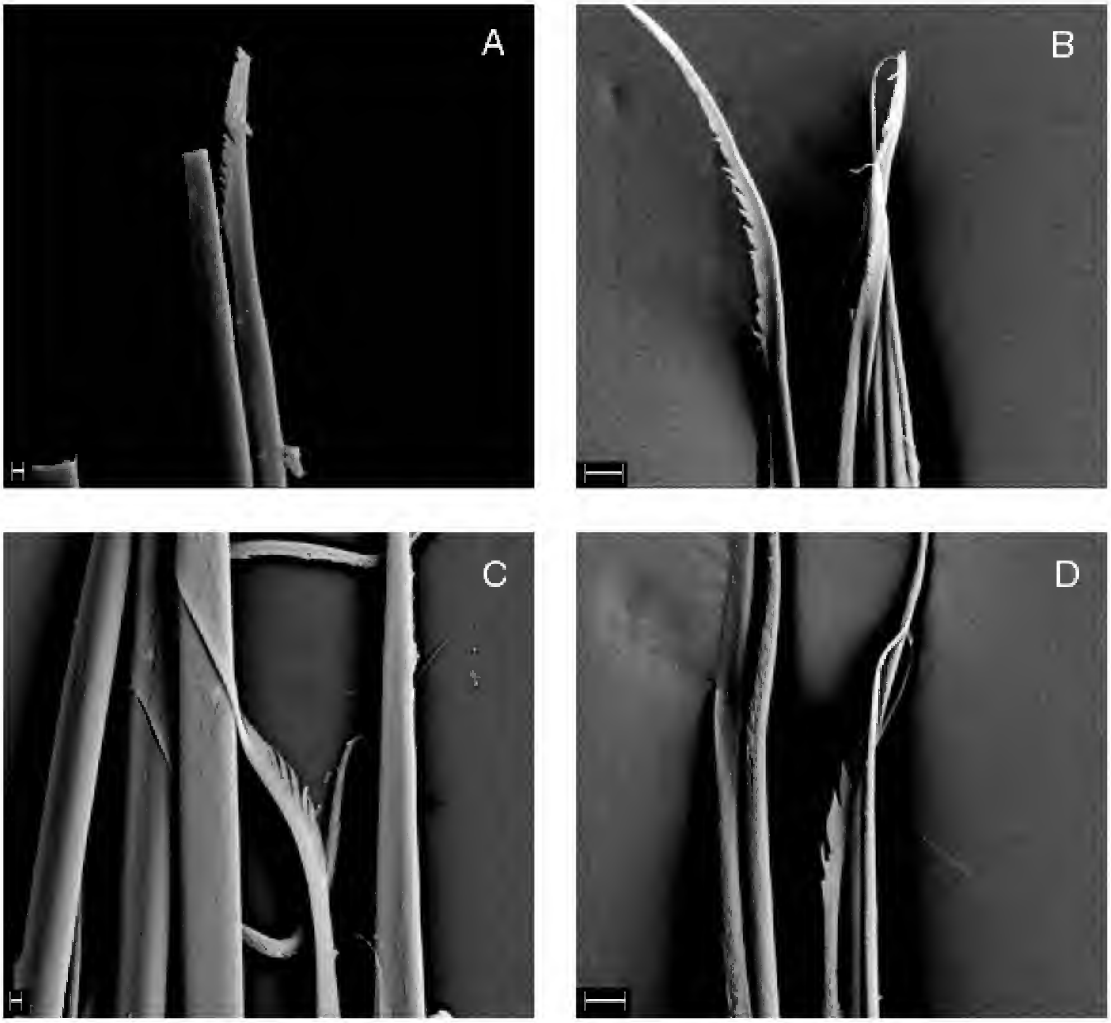


Figure 11. A, *Pectinaria dodeka* n.sp. notochaetae from chaetiger 4, scale = 3 µm. B, *Pectinaria dodeka* n.sp. notochaetae from chaetiger 14, scale = 10 µm. C, *Pectinaria kanabinos* n.sp. notochaetae from chaetiger 4, scale = 3 µm. D, *Pectinaria kanabinos* n.sp. notochaetae from chaetiger 14, scale = 10 µm.

those of chaetigers 4 to 14. Neuropodia wedge shaped, erect with margins becoming rounded posteriorly, glandular. Neurochaetae with major teeth arranged in two rows, 6–10 teeth per row (Figs. 12C, 15B–C).

Posterior scaphe and abdomen distinctly separated. Posterior 5 segments fused to form a flattened plate or scaphe broader than long, with crenulated margins. Scaphe with an anal flap and dorsal papilla. Eight pairs of scaphal hooks, broad, blunt, brown (Fig. 12D). Prominent glandular areas present on chaetigers 4 to 17, and ventral areas of segments 1 to 6 also glandular. Triangular gland present between segments 2 and 3, situated mid-ventrally. Segments 3 and 4 with raised glandular anterior margins extending across venter. Paired nephridial papillae on chaetiger 1, inserted ventrally at the base of the second pair of branchiae.

Variation. The number of cirri on the cephalic veil margin varies from 16 to 28, the number of pairs of paleae varies from 11–13, and the number of scaphal hooks varies from 6 to 10 pairs, and this appears to be related to size with larger animals having more cirri, paleae and hooks than smaller individuals. The anterior pair of branchiae in some specimens are of similar size to the posterior pair. The intensity of the glandular areas varies.

Remarks. *Pectinaria dodeka* n.sp. can be distinguished from all other described species of *Pectinaria* by the following combination of characters: 16–18 pairs of cirri on the cephalic veil, 11 to 13 pairs of subacute dorsally curved paleae and 6–10 pairs of scaphal hooks (see Table 4). The species most closely resembles another Australian species, *P. kanabinos*, in terms of the number of cephalic cirri present, but can be distinguished from it by the shape of the paleae: subacute curved dorsally in *P. dodeka* and acute needle shaped in *P. kanabinos*. In addition, the shape of the scaphe and the number of pairs of scaphal hooks differs between the two species. The species may be separated from *P. antipoda* by the lack of rounded papillae on the anterior margin of the anteroventral lobe of chaetiger 2. Many other species have a similar number of paleae, although as is clear from Table 4, some species exhibit a considerable range in the number of pairs present; this may be a function of size of individuals or perhaps an indication that the paleae can be replaced if damaged during feeding. The absolute number of pairs of paleae may not be a useful character.

Material identified as *P. brevispinis* by Monro (1931) (BMNH 1931.7.1.61; 1931.7.60.) from Low Isles, Queensland has been re-examined and we have referred

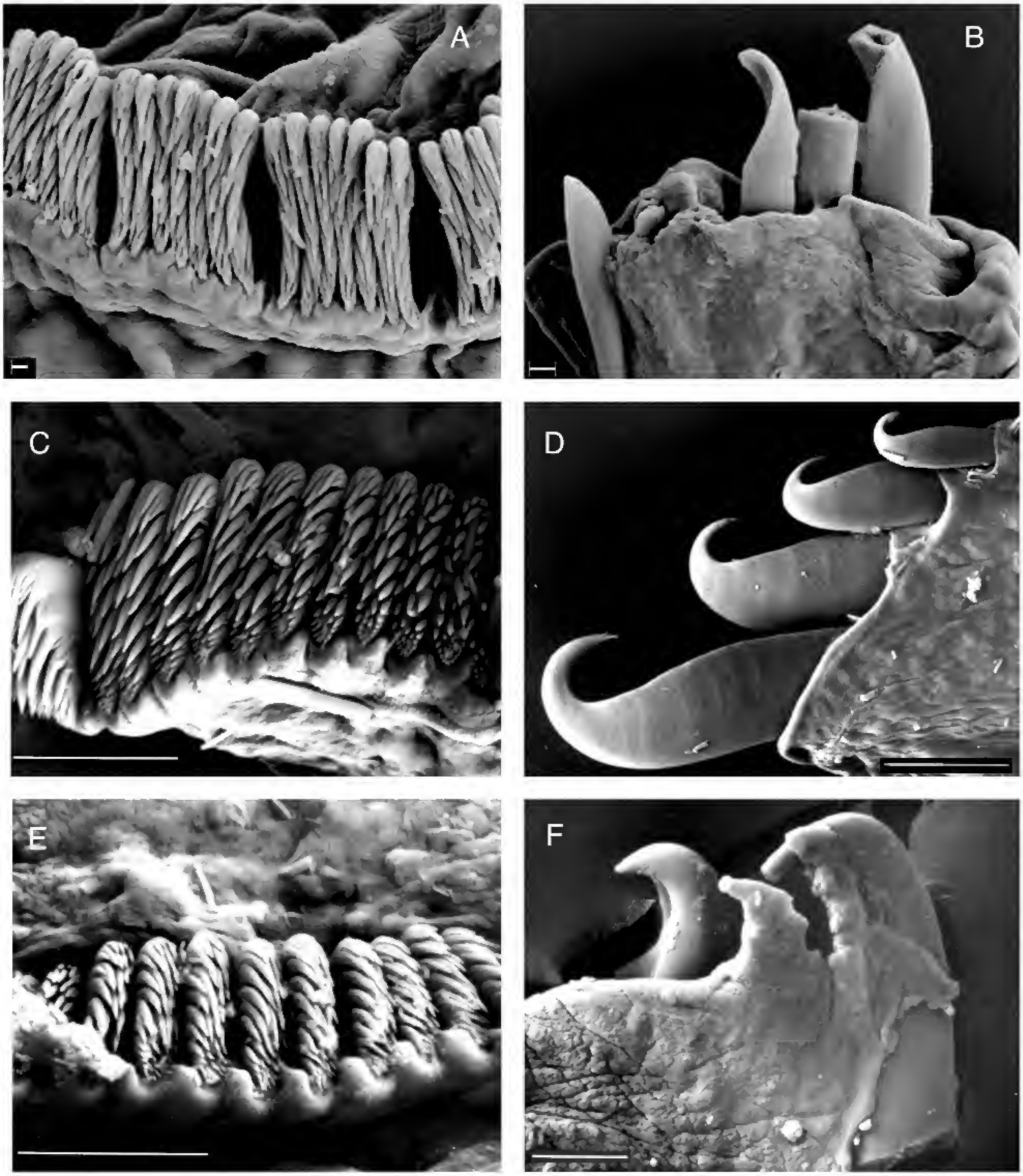


Figure 12. A, *Pectinaria antipoda* (Schmarda, 1861) neurochaetae from chaetiger 8, scale = 3 µm. B, *Pectinaria antipoda* (Schmarda, 1861), scaphal hooks, scale = 10 µm. C, *Pectinaria dodeka* n.sp. neurochaetae from chaetiger 8, scale = 20 µm. D, *Pectinaria dodeka* n.sp. scaphal hooks, scale = 50 µm. E, *Pectinaria kanabinos* n.sp. neurochaetae from chaetiger 8, scale = 20 µm. F, *Pectinaria kanabinos* n.sp. scaphal hooks, scale = 20 µm.

them to *P. dodeka* n.sp. as well as material he identified as *P. antipoda*. *Pectinaria dodeka* n.sp. can be distinguished from *P. brevispinis* by the number of cirri on the cephalic veil, 16–28 in *P. dodeka* and 25–30 on *P. brevispinis*, and the number and shape of scaphal hooks present.

Material identified as *P. antipoda* by Stephenson *et al.* (1974) from Moreton Bay was re-examined and consisted of both *P. antipoda* and *P. dodeka* n.sp.

Etymology. The specific name *dodeka* is from the Greek word for twelve and refers to the number of pairs of paleae present on the holotype.

Distribution. Gulf of Carpentaria, and the east Australian coast (Fig. 13), often associated with estuarine or sheltered waters.

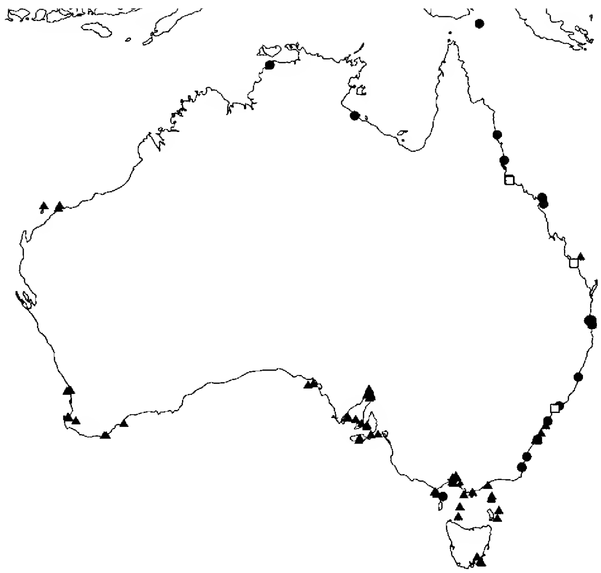


Figure 13. Distributional map for the Australian species of *Pectinaria*. ▲ *Pectinaria antipoda* Schmarda, (1861). ● *Pectinaria dodeka* n.sp. □ *Pectinaria kanabinos* n.sp.

Habitat. Collected from shallow waters to depths of 82 m, in soft sediments, sometimes associated with seagrass beds. Habitat data are lacking for many specimens.

Pectinaria kanabinos n.sp.

Figs. 11C–D, 12E–F, 13, 16A–B, 17A–C, Tables 4, 6

Type material. HOLOTYPE: 1, AM W25616*, 24.vi.1975, 14 mm long, 3 & 2 mm wide. PARATYPES: 1, AM W8534*, 24.vi.1975, 16 mm long, 4 & 2 mm wide; 1, AM W8535*, 24.vi.1975, 18 mm long, 3 & 2 mm wide; 1, BMNH 2001.67*, 26.xi.1975, 15 mm long, 4 & 2 mm wide.

Type locality. Queensland, Calliope River, north of Gladstone, 24°01'S 150°59'E, collected by P. Saenger.

Additional material examined. NEW SOUTH WALES: Lake Macquarie, Black Neds Bay, 32°59'S 151°38'E, 1, AM W7724*. QUEENSLAND: Halifax Bay, north of Townsville, 19°10'S 146°38'E, 5 m, i.1977, 1, AM W202174; 5 m, vii.1977, 2, AM W202186*; 5 m, vi.1977, 1, AM W202174; 2 m, i.1977, 1, AM W202176*. Material examined ranged from 10 to 24 mm long & 1 to 5 & 0.5 to 3 mm wide.

Description. Preserved specimen grey to pale cream in colour, body not robust. Rim of cephalic veil with 15 long cirri tapering evenly to fine thread-like tips. Cephalic veil completely free from operculum forming dorsal semi-circle surrounding numerous peristomial palps. Peristomial palps papillose, thick and numerous.

Raised opercular margin well developed and smooth. Operculum with 14 pairs of paleae, pale, clear, pointed gradually tapering to fine tips, curved dorsally, long (Fig. 16A).

First pair of tentacular cirri inserted on anterior edge of segment 2. Ventral ridge connecting second pair of tentacular cirri on segment 3 incised to form glandular lobes. Chaetiger 2 with anteroventral lobe large and broad; anterior margin of lobe smooth; posterodorsal lobe absent. Two pairs of well-developed, comb-like, stalked branchiae, consisting of loose, flat lamellae, lying flattened against the body.

Chaetigers 1 to 3 (segments 5 to 7) with notopodia and notochaetae only. Chaetigers 4 to 16 with both notopodia, neuropodia, notochaetae and neurochaetae. Notopodia and notochaetae of chaetigers 1 to 3 and 15 to 17 reduced in size compared to those on chaetigers 4 to 14. Chaetiger 17 with notopodia and notochaetae only. Notochaetae capillaries of varying length with one margin strongly pectinated (Figs. 11C–D, 17A). Neuropodia wedge-shaped, with rounded margins from midbody onwards, posteriorly the ventrolateral margins becoming hook-shaped. Neurochaetae with major teeth arranged in two vertical rows with about 12 teeth per row, although the basal teeth are small and difficult to count (Figs. 12E–F, 17B–C).

Posterior scaphe and abdomen distinctly separated. Posterior 5 segments fused to form a scaphe which is longer than broad, with crenulated margins. Scaphal hooks present, 5 pairs, fine, small, pale, colourless (Fig. 9F).

Glandular areas present as small pad-like areas on each segment present laterally along entire body length, and well-developed mid ventral glandular area between segments 2 and 3. Nephridial papillae not observed.

Variation. The number of cirri on the cephalic veil present varies from 10 to 16, 12–14 pairs of paleae and 4–6 pairs of scaphal hooks and does not appear to be related to animal size.

Remarks. *Pectinaria kanabinos* n.sp. can be distinguished from all other described species of *Pectinaria* by the following combination of characters: 10–16 cephalic cirri on the cephalic veil, 12 to 14 pairs of acute, needle-like paleae, and 4 to 6 pairs of fine scaphal hooks (see Table 4). The shape of the paleae is characteristic. Other species with fine paleae are *P. meredithi* Long, 1973, *P. papillosa* Caullery, 1944, *P. profunda* Caullery, 1944 and *P. californiensis* Hartman, 1941. All these species have a larger number of cirri on the cephalic veil, and more pairs of paleae and scaphal hooks than P. *kanabinos*, which for these reasons we describe as a new species.

Etymology. The specific name *kanabinos* is from the Greek word meaning long and slender, which describes the paleae of this species.

Distribution. Species described from two locations in Queensland, and one specimen collected from Lake Macquarie, New South Wales (Fig. 10).

Habitat. Sheltered bays or rivers, with muddy sediments, in shallow depths.

Petta Malmgren, 1866

Tables 5, 6

Petta Malmgren, 1866: 361.–Fauchald, 1977: 120.

Diagnosis. Rim of cephalic veil with smooth margins. Cephalic veil completely free from operculum, forming dorsal semi-circle around numerous peristomial palps. Raised opercular margin smooth. Chaetigers 1 to 3

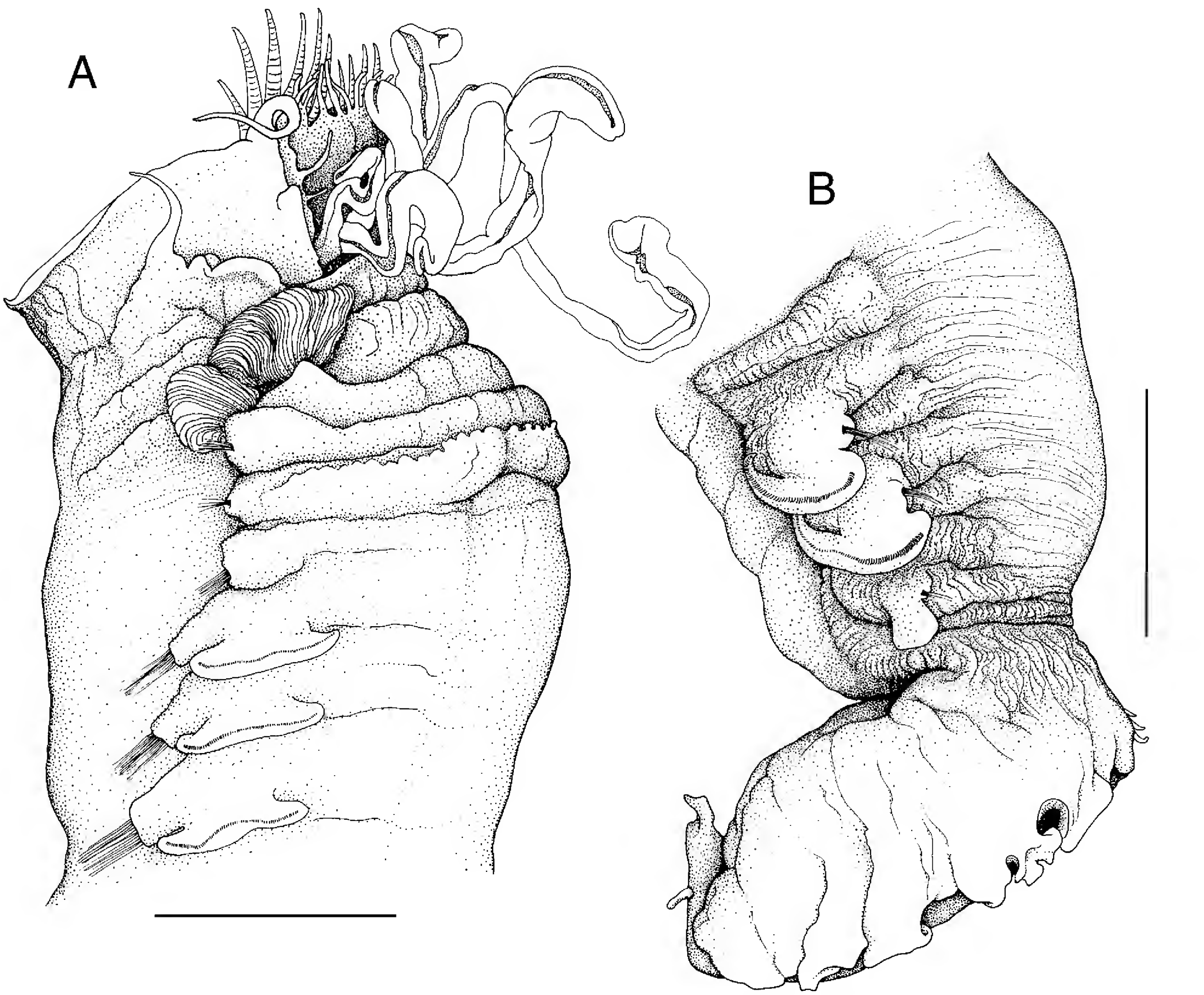


Figure 14. *Pectinaria dodeka* n.sp. Holotype (AM W25615). A, lateral view of anterior end, scale = 2 mm. B, lateral view of posterior end, scale = 1 mm.

(segments 5 to 7) with notopodia and notochaetae only, chaetigers 4 to 17 biramous with notopodia, neuropodia, notochaetae and neurochaetae, chaetiger 18 with notopodia and notochaetae only (18/14). Notochaetae all smooth capillaries. Neurochaetal uncini with major teeth arranged in one row. Posterior 5 segments fused forming flattened plate or scaphe, not distinctly separated from abdomen.

Type species. *Petta pusilla* Malmgren, 1866, by original designation.

Remarks. No Australian species have been recorded. The major diagnostic characters of the three species assigned to this genus are given in Table 5. Species are poorly differentiated from each other. Many characters that have been found to be useful in distinguishing species in other genera have not been described. All three species need to be redescribed. Two of them occur in deep water and only one species, *P. pusilla*, has been widely reported, although some of these records may need to be checked against material from the type locality. *Pectinaria tenuis* is known only from the type locality.

Table 5 (part). Major distinguishing characters of species of *Petta* (entries in parentheses are based on non-type material).

species	holotype length mm	holotype anterior width mm	nos. of pairs of paleae	shape of paleae	posterodorsal lobe (segment 2)	anteroventral lobe (chaetiger 2)
P. assimilis McIntosh, 1885	22	4.5 (3.5)	14	elongate, slender	*n.r.*	cirrate (7 or more pairs present)
P. pusilla Malmgren, 1866	15 (10–18)	3 (3–5)	11 (9–12)	flat, attenuated tip (short)	absent	absent (glandular)
P. tenuis Caullery, 1944	12	1.7	11	elongate, curved acute tip	*n.r.*	glandular

Discussion

Individuals belonging to the Pectinariidae are easy to recognise, but the systematics of this widely distributed family has been neglected. The confused identity of the common European species suggests that many species may have been misidentified or perhaps several species confused under one name. Certainly some of the species listed by Day & Hutchings (1979) from Australian waters do not occur there.

In this study, we have accepted all the previously recognised subgenera as full genera. The characters, that separate the five genera include: whether the cephalic veil is attached or free, the presence or absence of cirri on the cephalic veil and cephalic rim, the number of biramous thoracic chaetigers, the number of vertical rows of teeth on the neurochaetae, and the degree of separation of the scaphe from the abdomen (Table 6). We have also included for the genera represented in Australian waters, details of the capillary notochaetae which appears to be an additional generic character. Some generic characters overlap, and additional distinguishing characters are desirable. Although the number of uncinigerous segments is used as a generic character (see Table 6), we have also given the ratio of notopodia to neuropodia and differences between genera. However, not all species' descriptions include this information and in some cases we were able to determine

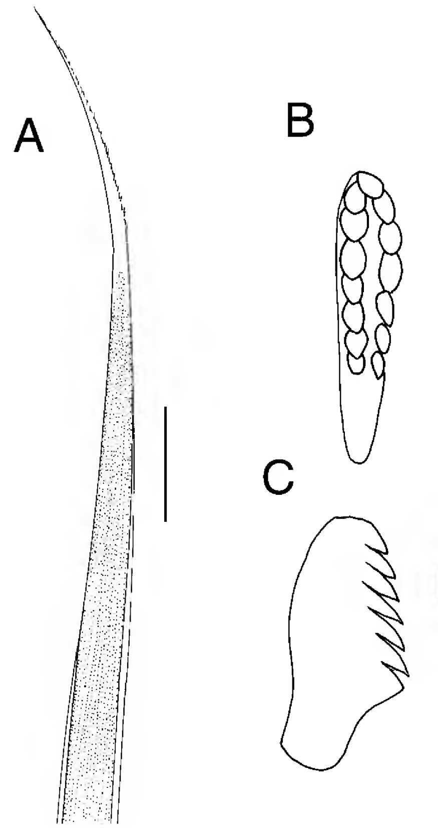


Figure 15. *Pectinaria dodeka* n.sp. Holotype (AM W25615). A, notochaeta from chaetiger 5. B, frontal view of neurochaeta from 6th uncinigerous segment. C, lateral view of neurochaeta from 6th uncinigerous segment. Scales = 100 µm.

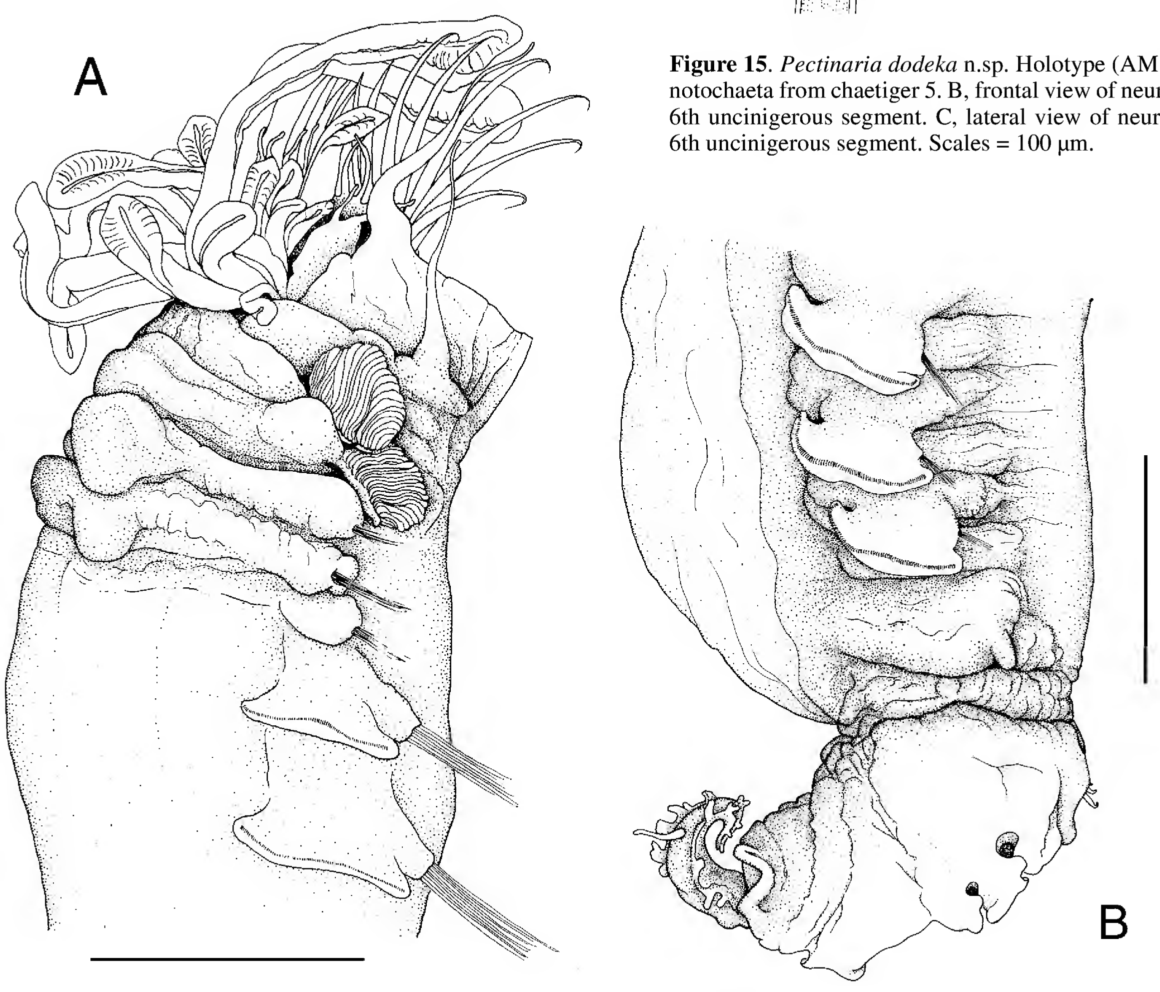


Figure 16. *Pectinaria kanabinos* n.sp. Paratype (AM W8535). A, lateral view of anterior end, scale = 2 mm. B, lateral view of posterior end, scale = 1 mm.

Table 5 (continued). Major distinguishing characters of species of *Petta*. (entries in parenthesis are based on non-type material).

species	chaetigers on which notopodia reduced	nos. of rows of teeth per uncinus	nos. of teeth within a row on uncinus	scaphal shape	scaphe: anal flap	scaphal hooks: nos. of pairs & type	tube, shape & construction	glandular areas	type locality	additional records and comments*
P. assimilis	*n.r.* (1–3)	*n.r.*	2	reduced (with 6 pairs of marginal triangular processes)	short, & conical with scale like process (not present)	*n.r.* (11, smooth, slightly falcate)	*n.r.* (fragile, covered with white *Globigerina* tests)	*n.r.*	between Prince Edward and Kerguelen Islands—2926 m	Recorded from Cape Horn, 1806–2013 m and Falkland Islands, 2452 m (Hartman, 1967).
P. pusilla	1–3, 18	*n.r.* (1)	*n.r.* (2)	oval, lobed margin (short, round, crenulated)	sub-filiform (cirriform)	*n.r.* (6–11)	slightly curved (made of sand grains and forams)	*n.r.* (strongly glandular)	Gullmarfjorden, Swedish west coast	(See below) w
P. tenuis	1–3	1	2–3	wide, crenulate edges	semi-circular with long narrow cirrus	8	*n.r.*	glandular	Indonesia (6°8'N 121°19'E)—275 m	Only known from the original record.

n.r. character not recorded.
* Only a selection of records are given based on the literature to indicate distribution of species, however distributions outside the region of the type locality require verification.
w [*pusilla*] Recorded from west coast of Sweden (Hessle, 1917); North Sea, English Channel, Atlantic Ocean, Azores, Irish Sea, Mediterranean Sea, Scandinavian coast, Arctic Sea (Fauvel, 1927); Faeroes, Kattegat, Scandinavia (Holthe, 1986).

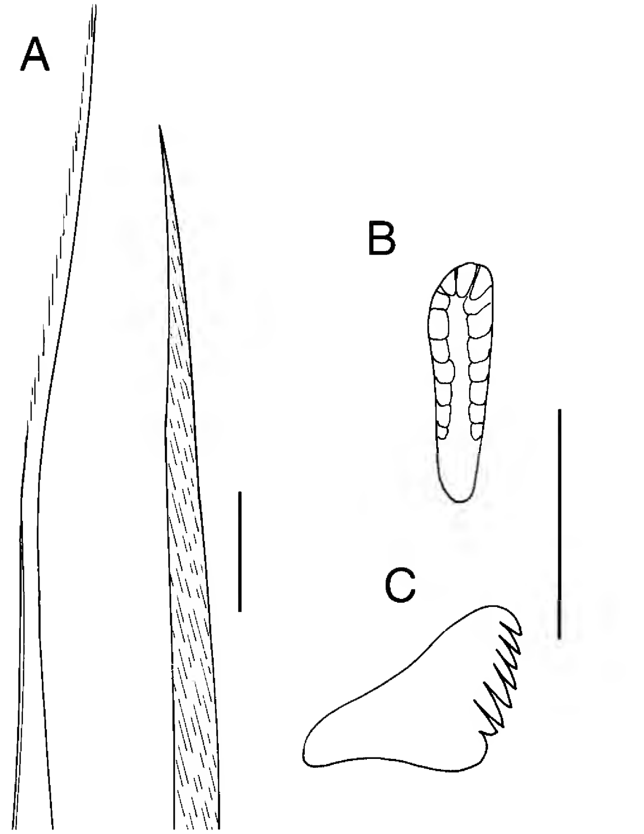


Figure 17. *Pectinaria kanabinos* n.sp. Holotype (AM W25616). A, two types of notochaetae from chaetiger 5. B, frontal view of neurochaeta from 6th uncinigerous segment. C, lateral view of neurochaeta from 6th uncinigerous segment. Scales = 100 µm.

this ratio from figures supplied. Some discrepancies with the generic diagnosis resulted, so the validity of the character needs further testing. Future studies should carefully document this ratio. Certainly some species have reduced posterior notopodia that may easily be overlooked especially in small individuals, resulting in an inaccurate ratio being given. Future studies need to clarify these generic characters, to avoid characters such as one of those in *Lagis*, where the cephalic veil is only partially fused, which may be open to interpretation.

Specific characters for the family include the number and shape of paleae, the number of cirri on the cephalic veil and the number of pairs of scaphal hooks. In *Pectinaria*, additional specific characters are the anteroventral lobe of chaetiger 2, which may possess lobes and the number of cirri on the dorsal raised opercular margin. These characters need to be well illustrated.

Many species are poorly known. Fifty three species of Pectinariidae have been described, of which 23 are known only from the type description. Many of these species need to be re-examined for diagnostic characters (see Tables 1–5). Features such as the shape of the scaphal hooks and paleae have often not been illustrated or compared with those of previously described species. The actual size of the paleae may not be diagnostic because they may be worn by digging. Damaged paleae were commonly seen and presumably can be replaced. Other factors that need to be

Table 6. Characters distinguishing genera of Pectinariidae.

genus	cephalic veil	opercular rim	chaetigers biramous (ratio of noto-neuropodia)	type of notochaetae	nos. of vertical rows of teeth on uncini	scaphe
Amphictene Savigny	free, cirrate	raised, cirrate	4–16 (17/13)	smooth & finely pectinated margins	2	distinctly separated
Cistenides Malmgren	free, cirrate	raised, smooth	4–16 (17/13)	?	1	distinctly separated
Lagis Malmgren	partially fused to bases of tentacular cirri, cirrate	raised, smooth	4–15 (16/12)	smooth	2 or 2+	distinctly separated
Pectinaria Savigny	free, cirrate	raised, smooth	4–17 (17/14)	smooth & cirrate	2	distinctly separated
Petta Malmgren	free, smooth	raised, smooth	4–17 (18/14)	smooth	1	not distinctly separated

considered in future studies are characters exhibiting variation in numbers with size and presumably age. These include the number of paleae and the number of cirri on the cephalic veil. Detailed morphometric studies should be carried out to ascertain the variation of these character within a species.

The position of nephridial papillae differs between *Amphictene favona* and *P. antipoda* but whether this represents a consistent generic difference is unclear. In all the other species that we examined, the position of these structures could not be determined and has rarely been reported in the literature. Further work is needed to clarify this.

Of the five described genera, four occur worldwide and one, *Cistenides*, has a restricted distribution. Three genera, *Cistenides, Petta* and *Lagis*, do not occur in Australian waters. The diagnostic characters of the species recorded in the Tables 1–5 are based mainly on the literature. We have moved species that obviously belong in another genus, but other species may also need to be reassigned once they are re-examined. Variation in characters described from non-type material has been included in brackets in these tables, and some additional records of species may prove to be misidentifications.

ACKNOWLEDGMENTS. We thank Kristian Fauchald for his thoughts on the validity of the manuscript prepared by Savigny. We are also grateful to Miranda Lowe (BMNH), Hilke Ruhberg (HZM) and Birger Neuhaus (ZMB), for the loan of material, and to the Collection Managers at various Australian State Museums for the loan of their pectinariid material. Alex Muir provided us with information about the collector of the neotype of *P. antipoda*, and Tom Miura provided us with a copy of a Japanese paper. Anna Murray prepared some figures and Kate Attwood prepared the plates (both AM). The Australian Bureau of Flora and Fauna provided the salary of one of us (RP).

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Manuscript received 29 May 2000, revised 19 January 2001 and accepted 13 February 2001.

Associate Editor: G.D.F. Wilson.

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